GOVERNMENT OF INDIA

ARCHÆOLOGICAL SURVEY OF INDIA

ARCHÆOLOGICAL
LIBRARY

ACCESSION NO. 31569

CALL No. 061.05/P.A.P.S

D.G.A. 79

PROCEEDINGS

OF THE

American Philosophical Society

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE

VOLUME LXXI

1932

061.05
P.A.P.S.

PHILADELPHIA
THE AMERICAN PHILOSOPHICAL SOCIETY

1932

~~A142~~

CENT... OGICAL
LIBRARY, NEW DELHI.
Acc. No. 31569
Date 29.5.57
Call No. 061.05/P.A.P.S.

LANCASTER PRESS, INC.
LANCASTER, PA.

CONTENTS

LIST OF ILLUSTRATIONS

PLATES

LINE CUTS

ABSTRACTS OF THE MINUTES OF THE MEETINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

DURING 1932

Stated Meeting, January 8, 1932

HENRY NORRIS RUSSELL, Ph.D., D.Sc., President in the Chair.

A letter was received from Henry Norris Russell accepting election as President to fill the unexpired term from December 1931 to May 1932.

The following papers were read:

"The Railroad Situation: Suggestions as to the way out," by Emory R. Johnson, Ph.D., Sc.D., Dean of the Wharton School of Finance and Commerce, University of Pennsylvania.

"A Way for the Railways to keep out after they are out," by Alba B. Johnson, LL.D., President of the Railway Business Association.

"Coördination as a "Way-Out" of the Transportation Crisis," by G. Lloyd Wilson, Professor of Commerce and Transportation, Wharton School of Finance and Commerce, University of Pennsylvania.

Stated Meeting, February 5, 1932

HENRY NORRIS RUSSELL, Ph.D., Sc.D., President in the Chair.

Alexander Forbes, recently elected member, subscribed the Laws and was admitted into the Society.

The decease was announced of the following member:

Andrew J. Blair, at Philadelphia, January 25, 1932, æt. 84.

W. F. G. Swann, B.Sc., D.Sc., Director of the Bartol Research Foundation of the Franklin Institute read a paper on "The Significance of Hypotheses in Physics."

Monroe B. Snyder, M.A., read a paper on "The Whole Number Solution of the Problem of Chemical Combination."

Pending nominations were read.

Stated Meeting, March 4, 1932

Henry Norris Russell, Ph.D., D.Sc., President in the Chair.

The decease was announced of the following member:

David Jayne Hill, LL.D., Litt.D., D.C.L., Washington, D. C., March 2, 1932, æt. 81.

Dr. Brubaker read an obituary notice of Francis X. Dercum, President of the Society, 1927–1931.

S. S. Huebner, Ph.D., Sc.D., Professor of Insurance and Commerce, Wharton School, University of Pennsylvania and Dean of the American College of Life Underwriters, read a paper on "Unemployment Insurance." The paper was discussed by Emory R. Johnson, Harrison S. Morris and five guests.

General Stated Meeting, April 21, 22, 23, 1932

Thursday Afternoon, April 21st

Opening Session—2:00

Henry Norris Russell, Ph.D., D.Sc., President in the Chair.

The decease was announced of the following members:

Alexander Jay Wurts, Ph.B., M.D., at Pittsburgh, January 21, 1932, æt. 69.

Charles S. Hastings, Ph.D., at New Haven, January 31, 1932, æt. 84.

Max L. Margolis, Ph.D., at Philadelphia, April 2, 1932, æt. 65.

Wilhelm Ostwald, Sc.D., LL.D., at Leipzig, April 4, 1932, æt. 78.

Benjamin K. Emerson, Ph.D., LL.D., at Amherst, April 7, 1932, æt. 88.

Louis A. Bauer, C.E., M.S., Ph.D., Sc.D., at Washington, April 13, 1932, æt. 66.

The following papers were read:

"Recent Progress in Leprosy Control," by Victor G. Heiser, Associate Director of the International Health Division, Rockefeller Foundation, New York. Discussed by a guest.

"Problems and Observations Concerning the Transmission of "Blackhead" Infection in Poultry," by E. E. Tyzzer, Professor of Comparative Pathology, Harvard University.

"The Evolution of Bioluminescence and its Relation to Cell Respiration," by E. Newton Harvey, Professor of Physiology, Princeton University. Discussed by Dr. Russell.

"Comparison of the Time of Conduction of Sensory Impulses to the Brain with the Time of Reflex Response in the Spinal Cord," by Alexander Forbes, Associate Professor of Physiology, Harvard Medical School.

"The Mechanism of Sustained Muscular Contractions," by D. W. Bronk, Professor of Biophysics and Director of the Eldridge Reeves Johnson Foundation for Medical Physics, University of Pennsylvania. (Introduced by Dr. Donaldson.)

"Growth-rates and Larval Instars of Dragonflies of the Genus Anax," by Philip P. Calvert, Professor of Zoology, University of Pennsylvania.

"The Basal Heat Production of Elderly Women," by Francis G. Benedict, Director of the Nutrition Laboratory, Carnegie Institution of Washington, and Mary Henderson Meyer.

"The Growth of Nerve Fibers," by Carl C. Speidel, Professor of Anatomy, University of Virginia. (Introduced by Dr. McClung.) Discussed by Dr. Winsor.

"Further Studies of Autosynthetic Cells," by George W. Crile, Director of the Cleveland Clinic and of the Cleveland Clinic Hospital.

Friday Morning, April 22nd

Executive Session—9:30

HENRY NORRIS RUSSELL, Ph.D., D.Sc., President in the Chair.

Earnest A. Hooton, Waldo G. Leland, Arthur F. Buddington, and Dugald C. Jackson, recently elected members, subscribed the Laws and were admitted into the Society.

The President delivered his annual report and appointed the Committees on Nominations and General Meeting.

The proceedings of the Council were submitted and the nominees were recommended for election.

The following resolution was adopted:

RESOLVED That the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge hereby accepts its share of the Estate of Richard A. F. Penrose, Jr., deceased, bequeathed to it by his will, proved and registered in Philadelphia, August 6, 1931, and agrees to comply with all the terms and conditions of said bequest.

The Society proceeded to an election of officers and members.

The Tellers subsequently reported that the following officers and members had been duly elected:

President

Roland S. Morris

Vice-Presidents

James H. Breasted
Elihu Thomson
Edwin G. Conklin

Secretaries

Arthur W. Goodspeed
John A. Miller

Curator

Albert P. Brubaker

Treasurer

Eli Kirk Price

Councillors

(To serve for three years)

Cyrus Adler
Henry H. Donaldson
Herbert S. Jennings
William L. Phelps

1932–1934

Heber D. Curtis

Members

Edward Goodrich Acheson
Edward Cooke Armstrong
Gilbert Chinard
Ralph Erskine Cleland
Arthur Jeffrey Dempster
Arnold Dresden
Herbert Fox
Edwin Francis Gay

George Lincoln Hendrickson
Edwin Walter Kemmerer
Thomas William Lamont
Arthur Oncken Lovejoy
Elmer Drew Merrill
John Raymond Murlin
Charles Pollard Olivier
Ernest Minor Patterson
Henry Arthur Sanders
Jacob Richard Schramm
Charles Phelps Smyth
Edward Lee Thorndike
Richard Chace Tolman
Henry Van Peters Wilson
Sewall Wright

Foreign Members

Ramon y Cajal
William H. Collins
David Hilbert
Emmanuel de Margerie
Ivan Pavlov

Morning Session—10:00

HENRY H. DONALDSON, Ph.D., Sc.D., in the Chair.

The following papers were read:

"The Humanism of Cicero," by Edward Rand, Professor of Latin, Harvard University. Discussed by Professor Scott.

"The American Council of Learned Societies and its Relation to Humanistic Studies," by Waldo G. Leland, Permanent Secretary and Executive Director of the American Council of Learned Societies.

"The Art Called Modern," by Harrison S. Morris. Discussed by Dr. Albright and Professor Scott.

"The Activities of the Members of the American Philosophical Society in the Early History of the Almshouse (Philadelphia General Hospital)," by Robert J. Hunter. (Introduced by Dr. de Schweinitz.) (Read by title.)

"Wilkes Land Revisited," by William H. Hobbs, Professor of Geology and Director of the Geological Laboratory, University of Michigan.

"Recent Development of Applied Geology," by Charles P. Berkey, Professor of Geology, Columbia University.

"Ancient Erosion Surfaces in the Appalachians," by Douglas Johnson, Professor of Physiography, Columbia University. Discussed by Dr. Hobbs and Mr. H. S. Morris.

"The Lower Devonian Fishes of Bear Tooth Butte, Wyoming," by William L. Bryant, Director of the Park Museum. (Introduced by Dr. Sinclair.) (Read by title.)

"A Probable Fossil Relative of the African Aardvark from the Wyoming Eocene," by G. L. Jepsen, Princeton University. (Introduced by Dr. Sinclair.)

"Princeton Expedition to Patagonia," by William B. Scott, Professor of Geology, Princeton University.

Afternoon Session—2:00

ELIHU THOMSON, Ph.D., D.Sc., LL.D., Vice-President in the Chair.

Ernest E. Tyzzer and George O. Squier, recently elected members, subscribed the Laws and were admitted into the Society.

The following papers were read:

"New Light on Semitic Origins," by George A. Barton, Professor of Semitic Languages, University of Pennsylvania.

"The Decipherment of Canaanite Cuneiform and of Hittite Hieroglyphs, a Study in Method," by William F. Albright, Professor of Semitic Languages, Johns Hopkins University.

"Excavations at the Temple of Deir el Bahri," by Herbert Winlock, Director of the Metropolitan Museum of Art, New York. (Introduced by Dr. Adler.)

"The Harvard-Pennsylvania Explorations in a Late Neolithic Fortress in Bohemia," by Vladimir J. Fewkes, Director of the Harvard-American School of Prehistoric Research. (Read by Dr. MacCurdy.)

"The Coming of Man from Asia in the Light of Recent Discoveries," by Aleš Hrdlička, Curator, Division of Physical Anthropology, U. S. National Museum, Smithsonian Institution. Discussed by Professor Scott.

"Preliminary Remarks on the Anthropology of the American Criminal" (Broadcast by the Columbia Broadcasting Company), by E. A. Hooton, Professor of Physical Anthropology, Harvard University. Discussed by Drs. Davenport, W. A. Noyes, Hrdlička, Cheyney, Russell and W. B. Scott.

"Fire and Human Civilization," by Walter Hough, Head Curator of Anthropology, National Museum of Washington. (Introduced by Dr. Adler.)

Friday Evening Lecture

Paul van Dyke, Professor of Modern European History, Princeton University spoke on "The Human Washington."

Saturday Morning, April 23rd

Morning Session—10:00

HENRY NORRIS RUSSELL, Ph.D., D.Sc., President in the Chair.

Ralph E. Cleland, Edwin Walter Kemmerer and Ernest M. Patterson, recently elected members, subscribed the Laws and were admitted into the Society.

The following papers were read:

"The Pneumatic System of Trees," by D. T. MacDougal, Research Associate, Carnegie Institution of Washington. Discussed by General Squier.

"The Effect of Ethylene Upon Living Organisms," by William Crocker, Director of the Boyce Thompson Institute for Plant Research.

"The Lost Yellow Water Lily, Nymphaea Stuhlmannii," by George T. Moore, Director of the Missouri Botanical Garden.

"The Vapor Pressure and Heat of Sublimation of Graphite," by A. L. Marshall, Research Laboratory, General Electric Company, Schenectady and F. J. Norton. (Introduced by Dr. Whitney.)

"Unusual Effects of Pressure on Solid Bodies," by P. W. Bridgman, Professor of Physics, Jefferson Physical Laboratory, Harvard University.

"The Engineering Aspect of Noise Studies," by S. K. Wolf, Manager of the Acoustic Consulting Department of the Electrical Research Products, Inc., New York. (Introduced by Dr. H. E. Ives.)

"On the Accuracy of Star Positions Obtained from Photographs of Large Angular Dimensions," by Frank Schlesinger, Director of the Yale University Observatory.

"Spectroscopic Discoveries at the Recent Total Eclipse," by Samuel A. Mitchell, Professor of Astronomy and Director of the Leander McCormick Observatory, University of Virginia. Discussed by Dr. Russell.

"Why the Markings of the Moon's Surface Cannot be of Volcanic Origin," by William LeRoy Emmet, General Electric Company, Schenectady. (Read by title.)

Afternoon Session—2:00

EMORY R. JOHNSON, Litt.M., Ph.D., Sc.D.,
in the Chair.

The following Symposium on "The Present Economic Situation" was presented:

"Past Crises in Retrospect and in Contemporary Opinion," by Victor S. Clark, Consultant in Economics, Library of Congress.

"The Gold Standard and the Present Economic Situation," by Edwin Walter Kemmerer, Professor of International Finance, Princeton University.

"International Factors in the Business Depression," by Ernest M. Patterson, Professor of Economics, Wharton School of Finance and Commerce, University of Pennsylvania.

"Certain Practical Aspects of the Situation," by Silas H. Strawn, President of the U. S. Chamber of Commerce.

"Improvements in Banking Practice Suggested by the Present Depression," by George W. Norris, Federal Reserve Bank of Philadelphia.

"Progress and Depressions and our American Dollar," by Irving Fisher, Professor of Political Economy, Yale University.

"Informal Discussion," by Frank W. Taussig, Henry Lee Professor, Harvard University.

Saturday Evening

The Annual Dinner was held at the Bellevue Stratford Hotel.

President RUSSELL presided and the toasts responded to were as follows:

"Franklin," James Brown Scott.

"Our Sister Societies," Howard McClenahan.

"Our Universities," Thomas S. Gates.

"The American Philosophical Society," William B. Scott.

Stated Meeting, November 4, 1932

EMORY R. JOHNSON, Litt.M., Ph.D., Sc.D.,
in the Chair.

Arnold Dresden, Herbert Fox and Charles P. Olivier, recently elected members, subscribed the Laws and were admitted into the Society.

The decease was announced of the following members:

Roland Thaxter, Ph.D., at Cambridge, April 22, 1932, æt. 74.

John Ashhurst, Litt.M., at Philadelphia, April 22, 1932, æt. 66.

William W. Keen, M.D., Sc.D., Ph.D., LL.D., at Philadelphia, June 7, 1932, æt. 95.

Graham Lusk, Ph.D., Sc.D., M.D., LL.D., at New York, July 18, 1932, æt. 66.

Jean Adrien Antoine Jules Jusserand, LL.D., at Paris, July 18, 1932, æt. 78.

Monroe B. Snyder, M.A., at Narberth, Pa., September 27, 1932, æt. 84.

Sir Everard im Thurn, K.C.M.G., K.B.E., C.B., LL.D., in Scotland, October 8, 1932, æt. 88.

Edwin Walter Kemmerer, Ph.D., LL.D., Research Professor of International Finance, Princeton University, read a paper on "The Gold Standard and the Present Depression," which was illustrated by three charts and discussed by Dr. Patterson and two guests.

Stated Meeting, December 2, 1932

ROLAND S. MORRIS, LL.B., LL.D., D.C.L., President
in the Chair.

The decease was announced of the following members:

Edward Washburn Hopkins, Ph.D., LL.D., at New Haven, July 16, 1932, æt. 75.

Francis L. Patton, D.D., LL.D., at Bermuda, November 26, 1932, æt. 89.

William K. Gregory, Ph.D., Professor of Palaeontology, Columbia University, and Curator of Comparative Anatomy and Ichthyology at the American Museum of Natural History read a paper on "Fish Skulls: A Study of the Evolution of Natural Mechanisms" which was illustrated by lantern slides and discussed by Dr. Conklin.

The minutes of the November Stated Meeting of the Council were read and approved.

The Annual Report of the Girard Trust Company, Trustees of the Building Fund was presented and on motion was referred to the Chairman of the Committee on Finance and subsequently to the Committee on Audit.

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR PROMOTING USEFUL KNOWLEDGE

VOL. 71 1932 No. 1

THE RAILROAD SITUATION: SOME SUGGESTIONS AS TO THE WAY OUT

By EMORY R. JOHNSON

THE diagnosis of economic ailments is not an easy task. The difficulty becomes especially exacting if the malady is present in a complex organization whose condition is determined by many external forces, industrial, social, political, as well as by managerial and technical factors inherent in the organization itself, as is true of the transportation system as a whole and of the railroad, which is the major division of the larger unity. Likewise in seeking to cure economic ills and maladjustments treatment is not easy. The patient cannot be segregated. The railroads cannot be sent to a hospital for treatment or a rest cure; they must go on with their work and remain subject to whatever adverse or favoring forces may be exercised by business rivals, by society, or by governments, local, state and national. Moreover, their progress is conditioned by technical and financial factors partly external as well as inherent.

For these reasons the doctor who may claim to have a sure cure for the present railroad weaknesses may well be distrusted. I lay no claim to being an economic doctor, specializing in railroad ailments. All I shall here attempt is to set forth succinctly the main facts as to the situation into which

the railroads have been brought during recent years by the development of rival transportation facilities, and by the policies that have been followed in railroad management and government regulation. Some suggestions as to the future policies that present conditions indicate to be wise will be made.

The present condition of American railroads is, of course, largely due to the current business depression. American railroads, like those in Canada, Germany, England and other countries, are passing through the same valley of depression that is being crossed by other industries and enterprises. At the present moment, this valley seems deep and wide, but the people of the United States and other countries will in time cross the valley and leave behind them its fogs and doubts and discouragements as the road onward leads up the gentle slope to where the air is clear and stimulating and the prospects are altogether pleasing. The sun will again shine upon the railroads as upon the other works of man.

The question that most needs to be answered is not the relation of the current and temporary business depression to the present plight of the railroads, but rather to what extent the future days of the railroads are to be clouded by the persistence of present troubles that are not temporary and will not be dissipated by the returning sunshine of business prosperity. To continue the figures of speech, there seems to be more than one road that the railways may take or be required to take to get out of their present situation. Some ways clearly lead to a region of clouds, others give promise of sunnier and brighter lands ahead. Moreover, by some roads there are more thorns and less fruit than by other avenues that may be chosen, if corporate foresight be keen and public policy be favorable.

Needless to say the railroad is an agency of transportation, but in any discussion of the present ailment of the agency it will be helpful to keep in mind just what the service of transportation is, what the railroad carrier's function has been and what it should be. The service demanded of and

rendered by a transportation agency today differs greatly from that performed by the railroads a few decades ago. The same kind of change has taken place in the services of production and distribution, indeed, economic services generally become more complete and of greater convenience and value to those served with the progressive development and improvement of facilities. Railroad transportation being an indispensable necessity to industry and to society has until recently expected shippers and travellers to adapt themselves to the facilities and methods found by the railroads to be most economical and most advantageous to the carrier.

American railway managements have industriously sought to develop traffic and, by technical improvements, to increase efficiency and reduce carrier costs; but until the automobile and truck began giving travellers and shippers flexible services adjusted to varying individual needs and wishes, it was assumed that those requiring services would adjust themselves to the business practices of the railroads whose facilities were developed and employed with reference to mass transportation. The railroad company assumed that its task as a carrier of freight was to transport goods from terminal to terminal, that its services began and ended on its rails, and that whatever additional carriage was required at or within terminal areas to connect shippers and consignees was to be performed by them. The task of connecting maker or merchant with buyer or consumer was not thought of as a coördinated service that could be best rendered by a single agency or organization, until the carriers by truck began to provide complete and flexible services such as shippers and consignees might desire.

When the bus and truck became their traffic rivals, the managers of the railroads failed to foresee the great use that travellers and shippers were to make of the highways. Instead of engaging promptly and largely in bus and truck transportation and using the new facilities to supplement and extend their services, the railroads regarded the motor as a competitor instead of a collaborator and sought to hold traffic

to the rails. The railroad operators might have used the new facility to connect their freight terminals with shippers and consignees, to establish feeder lines and to extend their services to sections not reached by their rails. We are now seeing the beginnings of this by the railroads, the policy having been forced upon them by their large loss of traffic and revenue. The railroads are now wisely taking up the use of trucks in terminals, and also between stations (for local freight). They are beginning to develop bus and truck lines in coördinated rail-motor services, and are offering travellers the choice of riding by rail or by bus or partly by one and partly by the other. Had this policy been adopted in 1920 and vigorously pushed, the railroads would have avoided large traffic losses and would have been able to develop motor transportation less expensively. They are now entering upon motor services after their competitors have occupied the field and have become carriers for those who formerly were patrons of the railroads. Moreover many large manufacturers and shippers who are now using their own trucks would probably not be doing so had coördinated flexible truck and rail services (such as are now being provided in many places) been made available when they were desired.

In making this criticism, it is well to remember that it is much easier to state what ought to have been, than to foresee what should be done. Criticism is less difficult than construction. Most of us, like the railroads in delaying their development of motor transportation, learn by our mistakes. However, those who really learn by their mistakes and take steps to correct them will make progress, as will the railroads in carrying out their present policy of developing motor transportation.

Inasmuch as the situation of the railroads in the United States today, except insofar as it is due to the temporary depression that affects all kinds of business, has been brought about mainly by the loss of traffic to their competitors, the highways, waterways and pipelines, it will be well to state some facts as to the facilities and services of these rival

carriers, and as to the volume of their traffic. It will be necessary to limit the statement to illustrative data in order to avoid making a wearisome presentation of statistical and other factual details. Those seeking more complete information will find it in the recently published Annual Report of the Interstate Commerce Commission which sets forth facts and figures presented by witnesses that testified at the hearings of the Commission in the case of the application made by railroad carriers last June for an increase of fifteen per cent in freight rates—a case that was decided the 20th of last October. The Commission has also just given out its Examiner's Report upon an investigation that it has made during the past year and a half "into motor vehicle operations, for the particular purpose of determining how these transportation agencies may best be coördinated with the operations of rail and water carriers in the interest of an adequate and efficient system of national transportation." This report not only contains information regarding motor transportation but also presents "recommendations with respect to the interstate operations of motor trucks." The findings, opinion, and recommendations of the Commission, based on the Examiner's Report, will soon be published.

Highway Transportation and Its Effect Upon the Railroads

At the beginning of 1931 there were about 3,000,000 miles of highways and 250,000 miles of railroad lines in the United States. By no means all of the roads are useable for automobiles, especially busses and trucks. Some 700,000 miles of the highways, about one-fourth of the total mileage, were surfaced, and, of this fourth, 128,000 miles were of the "high type," consisting mostly but not entirely, of concrete roads. Road improvement and extension are proceeding rapidly in spite of, or rather because of, the present business depression, there being about 50,000 miles of streets and roads constructed or rebuilt annually. The public is putting about $2,000,-000,000 into roads and streets each year. This is two and

one-half or three times the amount of new capital that went into the railways annually, before the present business depression temporarily made additional investments in railroads impracticable and necessitated special effort to safeguard existing capital.

Both private automobiles and motor trucks have increased in number with great rapidity. The 23,042,840 automobiles (including 95,400 busses) registered at the beginning of 1931 were nearly three times the eight and one quarter millions in 1920. Truck registrations rose from one million in 1920 to nearly three and a half million at the beginning of 1931. As is well known, the privately owned and operated automobiles and trucks greatly exceed in number those used for hire in commercial services. A study made by the Bureau of Public Roads of the United States Department of Agriculture indicated that 85.8 per cent of the trucks in service were in private operation, the remainder being divided between contract and common carrier services.

There are no general and complete statistics of the amount of freight being transported by motor trucks but there are many evidences that the traffic is large and is growing rapidly. Much of the package or less-than-carload freight formerly transported by rail now moves by truck and there is a surprisingly large amount of bulk or carload freight such as bricks, cement and livestock being carried by truck to relatively near-by consignees, and even to distant ones.

The records kept by the Philadelphia Chamber of Commerce list 230 motor truck operators performing contract and common carrier services within and out of the Philadelphia area. At St. Louis, as shown by a recent survey, there are "265 motor trucking companies engaged in regularly scheduled line-haul freight services." One company has eighty trucks. Some of the carriers operate to points 500 miles from St. Louis. The Traffic Department of the St. Louis Chamber of Commerce estimates, how accurately I cannot judge, that 75 per cent of all less-than-carload freight forwarded from St. Louis to points within 150 miles is shipped by truck, and thirty

per cent of all less-than-carload freight out of the city is so transported.

Perishable freight has been moving to consuming centers in increasing volume year by year. Of the fruit and vegetables received at New York City in 1928 from the principal producing districts in the Eastern part of the United States, 72 per cent came by truck. The strawberries and peaches of Maryland now reach Philadelphia and New York mainly by trucks, the rates and time of transit being less than by rail. In 1931, motor trucks transported 25 per cent of the grape crop, about 68 per cent of the apples and about 82 per cent of the peaches of Arkansas.

Naturally motor truck transportation is most largely developed within and out of the large urban areas, but data as to certain typical agricultural states as presented in the recent Annual Report of the Interstate Commerce Commission indicate a general use of trucks in less populous sections of the country. Most states require those engaging in a regular freight trucking service for hire to secure a certificate of public convenience and necessity. In Oregon, 165 firms have been authorized to operate on fixed schedules at fixed rates, and in 1930 they transported over 500,000 tons of freight. At the same time there were 582 truck operators in Oregon, carrying freight in contract services, but not operating over fixed routes. In Oklahoma, there were 204 operators upon scheduled truck routes and 321 other carriers by truck authorized to operate at fixed rates but not over established routes.

To illustrate the possible use of trucks for transporting freight that has been regarded as distinctly belonging to the railroads for movement in carloads reference may be made to coal, cotton and livestock. Coal to the amount of 400,000 tons a year now moves from Pennsylvania mines to consumers within 50 miles of the mines. In 1930, 500,000 tons of coal from the Illinois mines were carried to St. Louis by truck. Cotton is now being sent to market in large volume by trucks, thus taking from the southern railroads tonnage of great importance to them. Of the 4,000,000 bales of cotton grown

in Texas in 1930 1,200,000 reached the ports by truck. Livestock which is an important traffic for the railroads reaching Kansas City and other cattle markets has, since 1925, been moving more and more largely by truck. The Interstate Commerce Commission states, in the report above referred to that:

"In that year (1925) only 5.4 per cent of the total receipts at the Kansas City stock yards moved by truck, whereas, in 1930, 20.9 per cent moved by truck. The truck movement into the Wichita stockyards was 20.8 per cent of the total movement in 1925 and 47.9 per cent of the total movement in 1930. The number of livestock received at the 17 leading markets in 1925 was 5,378,868; in 1928 it was 12,193,058; in 1929 it was 14,510,524; and in 1930 it was 16,947,803."

It is interesting to note what steps the Western railroads have taken to endeavor to regain the livestock traffic. It was announced in the press, December 28, 1931, by A. F. Cleveland, Vice-President of the Chicago and Northwestern Railway, that the Western Lines have adopted a plan whereby the livestock is taken by truck from the farmer to the railroad, which advances the charge for trucking and collects from the commission merchant, to whom the stock is shipped, both the charge for trucking and the railroad freight charges. The commission merchant who sells the stock at the stockyards, sends the farmer the amount received less the commission and trucking and railroad charges. Mr. Cleveland also stated that the railroads have under contemplation the application of rates to minimum weights so much less than the present minimum to which carload rates apply "that livestock business in small quantities ordinarily handled by truck can be handled on a carload rate basis." By adopting a rate scale that will apply percentages of carload rates to minimum weights starting as low as 6,000 pounds there will be "a considerable saving to the shipper, who has but a small quantity of livestock to market, as the transportation costs will be materially lower than the present less-than-carload rates."

Whether this plan will enable the railroads to secure a larger share of the livestock traffic will be determined by the test of experience. The plan is especially interesting because it proposes to base the freight charge upon a smaller service unit than the carload. In fact it bases the freight charge upon a weight that the motor truck can carry. Mr. J. R. Turney, Vice-President of the St. Louis Southwestern Railway, in a most suggestive address that he made October 28, 1931 at a Meeting of the Associated Traffic Clubs of America, expressed the opinion that "The railroads are confronted with the choice of losing a substantial part of their carload business or of radically reducing carload minima, without however, sacrificing operating efficiency by diminishing car and train loads." Mr. Turney advocated the use of sectional freight cars and the reduction of minimum carload weights to correspond with the proposed sections of cars. By doing this and by placing the railroad rates on a level with truck charges, and by providing a coördinated truck and rail service from shipper to consignee (of which more will be said later) Mr. Turney believes the railroads can hold traffic against their motor-truck competitors.

The actual tonnage of traffic carried by trucks in 1931 and the extent to which this has reduced railroad tonnage can only be estimated. The most serious inroads that the trucks have thus far made upon the traffic of the railroad has been in the package or less-than-carload freight. This freight, before the days of the automobile, was barely five per cent of the total railroad tonnage, but it yielded nearly fifteen per cent of the freight revenue. Professor G. Lloyd Wilson, who has for several years been a close student of railroad and motor transportation, estimates that the trucks are now transporting fifty per cent of the total tonnage of package or less-than-carload shipments. This probably does not overstate the facts; and in view of the large amount of heavy bulk freight that is already being carried on the highways the same may probably be said of Professor Wilson's opinion that motor traffic as a whole is now equal to ten per cent of that

handled by the railroads. This would make the tonnage annually carried by truck more than 115 million tons, and would make the ton mileage of that traffic possibly 5 billion ton miles.

The most definite and serious inroad that has been made upon the traffic and revenues of the railroads has been made by the private automobile and by the busses which have already secured the major share of passenger transportation. In 1920 the passenger earnings of American railroads were nearly 21 per cent of their total operating revenues, but in 1930 they were only 13.8 per cent and the showing for 1931 is even worse. Ten years ago, when the Chamber of Commerce of the United States was considering some problems of railroad regulation, I was one of a committee of four that was asked to make an estimate of the increase in service demand that might be required of the railroads during the decade ending in 1931. The other members of the Committee were presumably intelligent, one being the statistician of the Interstate Commerce Commission, another the Director of the Bureau of Railway Economics, and the third the Manager of the Department of Transportation and Communications of the Chamber of Commerce of the United States. We made a study of the rate at which the railroad passenger traffic had increased decade by decade before 1921; and, after deciding that the rate would be lower in the future than it had been before 1921, we predicted an increase of 25 per cent during the ten years ending in 1931. Alas, how lacking we were in foresight! The railroad passenger traffic has not only not increased since 1921, but the earnings therefrom in 1930 were but 57 per cent of those of 1921, and in 1931 the railroads got less than half as much revenue from passengers as they did ten years ago.

We may assume that railway passenger travel has been below normal during the past two years, but it is manifest that the railroads cannot hope to secure from their passenger services as large a percentage of their total revenues as they have obtained in the past. The obvious course to pursue is

to correlate closely railroad and motor passenger services. By coördinating rail and highway facilities under a unified management each can be made to supplement the other and travellers will be provided with a service of maximum convenience. This coördination is being developed by numerous railroad companies, and the aeroplane is also being linked up with carriers by rail and bus.

Coastwise and Inland Waterways as Competitors of the Railroads

Transportation upon coastwise and inland waterways antedated the origin of railroads and throughout the hundred years of their development the railroads have had active competitors in the waterways. Toward the end of the last century the traffic on the inland waterways, except on the Great Lakes, became relatively unimportant, the rivers and canals, with the channels and facilities they then possessed, being unable to compete successfully with the railroads for other than local, low-grade commodities. On the Great Lakes and along the seaboard, until prevented by the prohibition in the Panama Canal Act of 1912, the railroads engaged in transportation by water through numerous steamship lines which they owned or otherwise controlled. Each of seven of the eastern trunk line railroads had a freight line on the Great Lakes, and several railroad companies had coastwise steamship lines on the Atlantic and Pacific seaboards.

The public, having always regarded the waterways as the special guardian that protected shippers against railroad monopoly and high rates, was opposed to the railroad ownership and operation of carriers by water, and were fearful that the railroads might prevent the free and large use of the Panama Canal route by intercoastal steamship lines. Accordingly when the time came to legislate for the operation of the Panama Canal, Congress prohibited the use of the Canal by vessels which the railroads owned or in which they had any financial interest. The railroads were also not to be allowed to own or operate on any waterways a vessel with which the

owner does or may compete, unless the railroad could convince the Interstate Commerce Commission that such ownership and operation would not substantially reduce competition and would be in the public interest. When the provisions of the Panama Canal Act were being worked out, twenty years ago, I favored, and still favor, not the prohibition but the government regulation of railroad ownership and operation of vessels upon the coastwise and inland waterways. Common carriers upon waterways should, like common carriers upon railways, be so regulated as to prevent unfair practices and unjust discriminations, and to assure equitable treatment of persons and places. At the present time railroads are regulated and carriers by water are not, except that through routes and rates by rail and water in interstate commerce may be established and regulated by the Interstate Commerce Commission.

Although the Commission does not make a definite recommendation, it is evident even from the guarded phraseology used both in its decision in the Fifteen Per Cent Case and in its last Annual Report that it favors government regulation of the port to port rates of interstate coastwise carriers. The Commission quite correctly states, in its Annual Report:

"The lack of stability and apparent demoralization from time to time of these rates, particularly those of the lines operating through the Panama Canal, at least suggest that some greater measure of public control may be in the interest of the water carriers themselves, as well as in the general interest."

As regards the regulation of carriers upon inland waterways the Commission is still more guarded in its statement, but one may judge that it leans towards the affirmative when it says that:

"It is strongly urged by the rail carriers that the water carriers are not bearing their fair share of the burden of the waterways, constructed or improved at public expense"

and that

"the contention of the rail lines presents a matter for unbiased investigation, which may be in need of correction if fair competitive conditions are to prevail."

Several special circumstances augment the present effect upon the railroads of the competition of their virtually unregulated competitors, the coastwise and inland waterway carriers. The close of the World War left the United States in possession of a large tonnage of shipping of which but a small share could be sold. Thus it was that vessels could be bought or leased of the government at small cost by American companies for operation in the coastwise and intercoastal services. A surplus of shipping was put into those services and the vessel rates, being subject to only very partial regulation of the United States Shipping Board, were made so much lower than the competing railroads could afford, or are allowed by the Interstate Commerce Commission, to charge that the traffic between the North Atlantic and Gulf Seaports, that along the Pacific Coast seaboards, and, especially that between the Atlantic and Pacific coasts, has in large part been transferred from the railroads to the steamship lines. The result has been unsatisfactory to both rail and water carriers neither of them being prosperous and the situation is one that in the long run cannot be in the public interest.

During the World War the United States government, in order to assure a maximum use of available transportation facilities while the war was being carried on, not only took over the management of the railroads, but also transportation on the several inland waterways including the Mississippi River. When after the war the railroads were returned to their owners the Federal Government continued to operate the Barge line it had established between St. Louis and New Orleans and between that city and Birmingport, Alabama, by way of Mobile and the Black Warrier River. Later, service on the Upper Mississippi between St. Louis and St. Paul was established. This government barge line, which is under the direction of the Secretary of War has since 1924 been operated by the Inland Waterways Corporation, which

was chartered by Congress, its stock being owned and its capital being supplied by the Government. The total appropriations made by Congress for the barge line and the Inland Waterways Corporation amount to $24,000,000 the present investment of the Corporation being somewhat less than that sum.

The Government's avowed purpose in operating the barge line on the Mississippi and Warrier Rivers has been to show that there is a demand for river transportation and that such transportation can be conducted at a profit. Having demonstrated this the Government plan is to sell out to a private common carrier. The financial results have not been encouraging to private capital. While the barge line has carried a considerable volume of traffic year by year, its total revenues during the past ten years have been somewhat less than operating expenses and allowances for depreciation. The Government has received from the Inland Waterways Corporation no interest on investment and no taxes on the property or on the revenues. It is hard to justify the continuance of business operation on this basis by the government in competition with private enterprise. It would seem that ten years is as long a time as such an experiment should last. Two common carrier barge lines operating from Cincinnati and from St. Louis to New Orleans have been established during the last few months; and are now struggling not only against adverse business conditions but also against the competition of the government and, of course, these private lines, as well as the Illinois Central Railroad which parallels the Mississippi from St. Louis to New Orleans (and which like most other railroads is hard hit by the present business depression), must pay interest or dividends to obtain capital and must pay their full share of taxes to the local, state, and National governments. Competition with a governmental enterprise under those conditions is unfair to private business and is a deterrent to private initiative.

No one will question the desirability and importance of adopting and carrying out a public policy that will bring about

an adequate, balanced, and coördinated development of all parts of the country's transportation system which includes the railroads, highways, waterways and airways. Care should be taken not to aid or promote one facility to the detriment of another, and the general purpose of government regulation should be two-fold, the protection of the public interest and the maintenance for all four forms of transportation full opportunity to develop in response to service demand. The inland waterways should be improved and where practicable should be connected; highway improvement and extension should be continued; but should those who use the waterways and highways as carriers for hire be relieved of burdens that must be borne by the owners and users of the railroads? I realize that this raises what the Interstate Commerce Commission rightly states is a controversial question. The Commission wisely recommends in its recent Annual Report:

> "That Congress provide for an impartial and authoritative investigation for the purpose of determining whether and to what extent motor, water, and air carriers operating in competition with the railroads are receiving direct or indirect government aid amounting, in effect, to a subsidy; and if so, what steps, if any, are necessary to correct this situation, with a view to placing competition on a just and equitable basis."

Pipeline Competitors of the Railroads

Traffic has of late been leaving the rails not only for the roads, waterways and the airways, but also for underground pipeline subways through which large quantities of oil, natural gas, and gasoline are now pumped to centers of consumption hundreds of miles from the regions of production. Formerly the tank car transportation of crude petroleum gave the railroads a large tonnage, but, although there has been a large increase in the output of petroleum during the past decade, the shipment by railroad has so decreased that in 1929 only 4.5 per cent of the production was transported by rail. There are 100,000 miles of crude-oil pipe lines in the United States in which an investment of $2,000,000,000 has

been made. These lines reach out from all the oil fields, some to great distances. From the Texas, Oklahoma and Southeastern Kansas field there are several lines not only to such centers as Kansas City, St. Louis and Chicago, but to Cleveland, Pittsburgh, Philadelphia, Baltimore, Buffalo, Syracuse and New York City.

Natural gas is now being piped through 65,000 miles of pipelines in the United States. These lines form a net work in some sections of the country, as, for instance, in Ohio, Eastern Indiana, Western Pennsylvania, Eastern Kentucky and Northern West Virginia. Similar networks are to be found in the section southwest of St. Louis and in California from Los Angeles to San Francisco. The rapidly increasing use of natural gas and fuel oil has cut down the consumption of coal and the tonnage of coal transported by rail. Pennsylvania produced about 18,000,000 tons less of anthracite coal in 1930 than in 1920; and it has been estimated that in 1929 natural gas was substituted for about 77,500,000 tons of bituminous coal.

The newest development of the use of pipelines has been for the transportation of gasoline. In 1931, there were 3800 miles of gasoline pipelines in service and several lines are being constructed. Gasoline is now piped from reservoirs on the Delaware and Hudson Rivers to Ohio points, and from Northeastern Oklahoma to Omaha, DesMoines, Chicago, Milwaukee and Minneapolis. The pipeline companies supply storage stations from which the gasoline is distributed over wide sections by trucks and barges. Tank barges take gasoline from a river terminal in Pittsburgh to points down the Ohio River.

The facts that have been presented as to the growth of traffic by highway, waterway, and pipeline readily explain why the freight traffic of the railroads increased but slowly even during the great revival of business following the World War. There was a gain of nine per cent in railroad tonnage and ton mileage during the ten years ending with 1929 when the business depression began, but the rate of increase was

much less than it had been during previous decades and was notably small in view of the rapid expansion in production and consumption that prevailed until the arrival of the sad autumn days of 1929.

Constructive and Corrective Measures Required

The foregoing analysis of the present railroad situation may indicate that the railroads are facing a future of much restricted usefulness with small prospect of returning financial prosperity. It is not my intention to give such an impression. I think the carriers by rail may look forward to brighter days. The railroads are today and will always be the principal part of the national transportation system, certainly as regards the transport of freight. If, as has been estimated, ten per cent of the freight tonnage is now being carried by truck, and if the present traffic on the waterways and through the pipelines is large and should it continue to increase as it doubtless will, yet it is probable that the railroads, which are now the carriers of fully three fourths of the tonnage of freight, will continue to transport by far the larger share of the vast traffic in a country whose people require each year fully 5000 ton miles of freight transport per person. Moreover, it is well not to forget that this country is going ahead in the future as it has gone ahead in the past, and that we are so organizing our social life and our individual way of living that more rather than less transportation per person is going to be necessary in the future.

1. Were the future prosperity of the railroad in large measure dependent upon passenger traffic, this optomistic prediction would not be warranted. The speedy, comfortable, flexible individually operated vehicle provided by the automobile of many types and the wide-spread and rapidly thickening network of good roads useable the year round will be used more largely than the railroad by those who travel. The railroads must needs reduce passenger operating expenses where possible by abandoning unprofitable train services, or substituting rail motor electric cars for local passenger trains

or by replacing branch line railroad operations with bus and truck lines. This is being done by the railroads, their action as regards each case of abandonment being subject to the approval of the Interstate Commerce Commission whose duty it is under the Transportation Act of 1920 to protect the public against being deprived of necessary transportation facilities.

Another policy that the railroads may wisely follow is one that is already being carried out by the Reading Railway and numerous other companies—the operation of bus lines through a subsidiary company. Such lines may be made to serve two general purposes, to provide an alternative service that those may choose who prefer to travel on rubber instead of on steel, to extend the services at the main stations to and from points beyond the railroad, thus giving travellers resident in the territory tributary to the railroad company's lines through bus and rail transportation between starting point and destination. This policy when generally carried out, will cause the railroad companies to provide complete passenger transportation by coördinated rail and bus services. This will involve problems of government regulation of services, charges, and competitive practices, but these are problems that experience, already had, should make easy of solution.

2. The railroads in the future must also engage in motor truck transportation to the extent necessary to accomplish two things: (1) They must meet the competition of other motor truck carriers by rendering a complete and flexible less-than-carload freight service from shipper to consignee. This will involve providing a collection and delivery service, at least in city terminals, and will probably require the development of several new facilities, such as freight containers and freight cars with sections whose capacity corresponds with that of the motor truck. Here again beginnings have been made, necessity being ever the mother of invention and the incentive to action. (2) The railroad companies must also, either directly or through subsidiaries or by contract with independent companies, use trucks to provide

extension and feeder services that will, so far as practicable, add to the present arteries afforded by the railroad trunk lines veins that will enable traffic to circulate throughout the territory served by the railroad.

3. The changes in railroad freight services made to meet the competition of the motor carriers and to coördinate motor and rail transportation should be, and are being, accompanied by the adoption of rates applicable to the service of shipper-to-consignee transportation both of less-than-carload freight and of such commodities, formerly moved only in carload lots, as are now being transported advantageously by trucks. The problem to be worked out by the railroad is so far as possible to furnish shippers complete and flexible service by using trucks for collecting and delivering freight and for aggregating truck load quantities into carloads and such carloads into train-load units for the speedy and economical movement that is possible by rail. Some of the freight handled by the motor trucks operated by or for the railroads will be taken from the shipper directly to the consignee by motor, but with a well worked out, coördinated motor and rail service, and with through charges appropriate to that service, it will be possible and profitable for the carrier to use the railroads for the long-haul or line-haul transport of freight in large units, and also at higher speed and lower cost than are possible for the motor truck.

4. It should be the policy of the railroads from now on to spend less effort and funds upon keeping traffic from moving by rival railroads and to place greater emphasis upon inter-railway coöperation. There is much wisdom in the statement made, on this point, by the Interstate Commerce Commission in its decision in the *Fifteen Per Cent Case:*

"In the past decade the railroads have made great strides in improving their service and at the same time operating with greater efficiency and economy. But what they have done in this direction has largely followed lines which developed under conditions different from those which now prevail, and it has been characterized by a continual in-

tensifying of their own competition. At a time when as an industry they have new enemies to face, their warfare with each other has grown more bitter, so that economies in operation have been offset in part by the growth of competitive waste."

What Lowell said years ago in discussing something very different from the present railroad situation seems equally pertinent:

> "New occasions teach new duties;
> Time makes ancient good uncouth;
> They must upward still, and onward
> Who would keep abreast of truth."

5. The consolidation or grouping of the railroads in the United States into a limited number of systems as evenly balanced and stable as practicable should be accomplished as soon as possible. The Transportation Act of 1920 should be amended by repealing the provisions requiring the Interstate Commerce Commission to prescribe in advance a general plan to be followed by the carriers in working out proposed consolidations, and the Commission should be free to pass upon each consolidation proposal upon its intrinsic merits. Moreover, the Commission should encourage the carriers to proceed with plans for consolidation. While protecting the public interest the Commission should avoid adopting a negative or obstructive policy, it being evident that the task of bringing about by voluntary action of the carriers the desired consolidation of the railroads as contemplated by the Transportation Act of 1920 will be difficult to accomplish even with a coöperative attitude on the part of the government.

6. There should be a larger measure of coördination of the railroads not only with motor transportation but also with the waterways, coastwise and inland. This will require the repeal of that part of the Panama Canal Act of 1912 that prohibits railroads from engaging in transportation by water, and the substitution of legislation applying to carriers on the waterways such government regulation as will safeguard all carriers on the waterways against unfair practices or de-

structive competition, and will encourage the development of transportation on the waterways while assuring to the public equitable rates for services rendered.

The railroads are free to engage in air transportation and are giving active support to the development of air lines. Much mail, many passengers and some high-grade express are now being carried over joint air and rail routes. These coördinated services may be expected to develop. No additional legislation seems necessary.

Apparently the long-distance movement of most crude petroleum, not transported coastwise in oil tankers, will be by pipelines which may also be expected to take from the railroads an increasing share of gasoline shipment. The railroads may well give attention to providing facilities for connecting pipeline terminals with large and small consumers thus serving as distributing agencies. This will require the railroads to coöperate with the oil companies, each rendering the services that can be most economically performed.

7. As has been suggested in this paper, the time has come for the government to work out the regulation of all transportation agencies in accordance with the same general public policy, but not necessarily by applying the same legislative provisions to all types of carriers. The aim of the government should be so to regulate the several agencies of transportation as to be helpful and constructive, not merely corrective. There has been a commendable change during recent years in legislation and in the spirit that animates those who administer the laws.

The Transportation Act of 1920 stipulated that the railroads should be so regulated as to further the development of an adequate national system of transportation and to yield the carriers a fair return upon the property devoted to the service of the public; and, while possibly no one may approve of everything done by the Interstate Commerce Commission, we will probably accept as correct the statement of the Commission that "the general tendency has been to preserve aggregate carrier revenues." The Commission suggests that

railway traffic departments "give new thought to the rate structure in the light of existing conditions." It favors "progress in unifications," and advises the railroads not to subordinate present coördination "to the necessarily slow realization of any consolidation program." The Commission has also recommended the repeal of the clause in the Interstate Commerce Act that provides for the taking by the Government of one-half of a railroad company's net earnings in excess of six per cent per annum upon the value of its property, and has also suggested other changes in the law that would be helpful to the carriers.

The tendency of the Commission in its zeal to protect the public interest, has seemed in the past to impose unnecessarily stringent limitations upon the revenues and the corporate management of the railroads. This spirit is not manifest in the recent Fifteen Per Cent Case nor in the last Annual Report. I think the Commission can and will be helpful to the railroads in getting out of their present situation.

8. It is especially important that the attitude of the public and of the government toward all agencies of transportation should be such as to strengthen corporate enterprise and to encourage private initiative and the investment of private capital. The road to government ownership and operation leads away from sunshine into shadow. The government especially in a democracy is not an efficient business organization. The development and management of the railroads and other transportation facilities in this great country is much too large and difficult an enterprise for successful government performance. The goal of the government should be the constructive regulation of corporate enterprise, regulation that will further the coördinated and balanced development of all transportation facilities and will assure to the public adequate services efficiently performed at rates that are equitable alike to the carriers and the public.

A WAY FOR THE RAILWAYS TO KEEP OUT AFTER THEY ARE OUT

By ALBA B. JOHNSON

Address before the American Philosophical Society, Philadelphia, Friday evening, January 8, 1932

I CONGRATULATE Dr. Johnson upon his survey of the complex situation now confronting our railways. Especially welcome is his hopeful tone. He thinks the various problems will be solved and that the railways, with whatever supplementary instrumentalities they may add unto themselves, will again be strong and prosperous, ready for the greatly increased traffic which he foresees. He speaks with the weight of high authority. With all that he says I am in accord. He does well to focus attention upon the legislative and regulatory phases and upon the opportunities and responsibilities of the railway managers in meeting or absorbing the newer forms of competition. I shall not attempt to enrich his analysis with any information or wisdom of my own.

It is to another part of the picture that I invite your attention. Dr. Johnson's sure instinct for literary flavor has led him to paraphrase an immortal quotation from a famous hymn. He predicts that the world will presently climb up out of the economic valley to where "the prospects are altogether pleasing." He refrains from reminding us that "where every prospect pleases only man is vile." May we agree that to be selfish is to be vile—that to enjoy the advantages of society whilst evading the sacrifices essential to its preservation entitles the citizen guilty of such shortsightedness to the condemnation visited upon the heathen by the missionary Bishop who sang that song?

This human problem—the necessity for the citizen to develop and practise public spirit in his daily business life—

goes deep into the roots of things and must continue to engage the attention of our successors in transportation as in everything else, on and on through all changes of scene.

Let us glance at the business man, the user of transportation, the shipper. I venture to think that if that element does not change its conception and its practice in daily dealings with the carriers it will make very little practical difference what is done by Congress or legislatures, by federal or state commissions, or by railway officials. A true analogy is the challenge given by the sage who said: "I care not who makes the laws of a nation if I may make its songs." What most needs reform is our business life, not the rules which are enacted for us to live by.

Some years ago in a private meeting where various phases of the railway problem had been discussed in papers and speeches, the chairman invited an eminent American to pronounce the benediction. Caught somewhat unawares, he rose and made observations not bearing very directly upon what had been said, but interesting and suggestive. Amongst other things he remarked that a little while before this an airplane had crashed in a wood near his home. "It might just as well have hit my house," he said, "and if it had there is every probability that it would have injured or killed one or more members of my family." He then enunciated the law of air rights. He had, he declared, title indefinitely upward. Anyone flying over his land was invading his property. Air traffic had been permitted to trespass in this way because property-owners had let the offense go without protest. The moral was that we should stand upon our rights, both for immediate protection from injury and for preservation of the rights themselves, which might become more valuable than they now appear. To me there is something heroic about that solitary figure, conducting his private revolution of resistance to airway development, his gaze fixed steadily upon his rights away up in the zenith. It is a losing fight. The most he can hope for is compensation in proceedings of eminent domain and safety regulations imposed to reduce his hazard.

Aviation has come to stay. Private considerations will not be permitted to stifle it. The general interest is paramount.

Paramount in the same degree is the public interest in rail service. The speaker whom I have quoted accused property-owners generally of guilty neglect in keeping their eyes glued to the earth when over their heads precious rights were being misappropriated and grave damage threatened.

A similar charge may be laid at the door of business men. Not only is rail service indispensable to the general public, but it is indispensable to each individual business man. In the still air of delightful studies at philosophical meetings, in calm conversation on the Riviera, in short wherever business men desire to appear broadminded, generous and civilized, they go much further. They concede or assert that rail service of the grade now become essential can only be assured under citizen ownership and management. Beyond this, thinking and speaking in the atmosphere to which I have referred, they view with alarm as a menace to democratic government a proposal for adding between one and two million railway workers to the army of federal employees.

Out of that mood of far-sighted vision and public-spirited devotion to ideals, the same business men return to business. The philosopher is again the shipper. If he keeps his eyes glued to the private interest of the moment, ignoring the larger and more permanent aspects, he is sinning against the light. He is guilty of inexcusable neglect, not only of the general business interest but of his own, not alone of business interest but of the welfare of the country, of civilization, and of posterity. In the zenith, if he will but turn his gaze in that direction, is something vastly more important for him to contemplate than his rights and his profits. Aloft, for him to study, embrace and perform, is his duty to society and in the long run to himself.

The situation is a practical every-day illustration of the pedestal upon which liberty and security rest. The American colonies became United States by the process of mutual concessions and sacrifices in the common interest. We

obtain security of person and property by universal adherence to a code. Whoever runs wild is a public enemy and is restrained. To preserve our present system of society we have to meet each new condition that is born of progress and develop first a code with regard to it and then a community habit of observing the code on pain of being made to feel in one way or another uncomfortable. The other day I heard a voice at a street corner say to a pedestrian who was watching the traffic: "Can't you see the signal?" "Yes," was the reply; "but I am not interested in what the motorist *ought* to be doing. I want to know what he *is* doing." The fundamental railway problem, as I see it, is for business men who recognize in cold blood the necessity for concerted business support in keeping the railways in fit financial condition for service and progress to establish mechanism providing constant contemplation of the shipper's duty in the zenith; unremitting vigilance and zeal in the performance thereof.

In the 15 per cent rate decision of Oct. 16, 1931 (p. 569), commenting on the wide belief that regulation has steadily reduced revenue by whittling rates, the Interstate Commerce Commission said: "It is well known that the railroads have themselves voluntarily reduced many rates for competitive and commercial reasons. The nonferrous metals are outstanding examples, the rates on which the carriers have reduced for one cause or another to such an extent that, in general, the increase which we granted in 1920 has been wholly eliminated together with a substantial part of the increase made by the Director General of Railroads during the period of federal control. Other illustrations in the case of transcontinental traffic, lumber, petroleum and its products, cotton and numerous other commodities are familiar." On earlier occasions, the Commission declared that opportunities to increase rates had been initiated by it and not availed of by the railways. Informally individual Commissioners have gone further. They have asserted that railway traffic officials, confronted by heavy shippers resisting advances or de-

manding reductions had neither the courage to enforce obviously essential rate levels where shippers controlling large traffic threatened diversion to competitive routes nor the unity to defy the shippers in concert.

Whether these assertions are true or not I do not know first hand. What is said sounds very familiar. It was the inability of the railroads to assure their own solvency through maintenance of remunerative rate levels that led to the creation of the Interstate Commerce Commission. That body originated in the need not for restriction of the roads but for their protection against themselves and one another. We have always this evil with us. If we cure it we shall avoid government ownership. If we do not cure it, federal seizure is only a question of time.

Some members of the Interstate Commerce Commission have thought fit to describe railway officers as "cowards." That is not an altogether fortunate source of such a characterization. As Dr. Johnson truly says, the Commission has recently manifested a most encouraging appreciation of railway financial difficulties. Elsewhere I have participated in warmly greeting this policy. But the Commission still leaves the exercise of courage to the railway officers. The Commission has by statute both the authority and the explicit mandatory duty to stand up to big shippers, serving as the people's agent for preservation of the carriers, and to stop the rate whittling which is deplored in the 15 per cent decision. It is declared by some critics that the Commission hadn't nerve enough to insist upon what it now declares to have been necessary. Perhaps the individual Commissioner is ambitious to serve his country long and well and realizes that if vindication of valor merely involves being thrown out of office, he will have deprived the public of a valuable servant on a minor issue. We may confess that when pressed by shippers the individual railway yields. So yielding does it more than obey the law of immediate self-preservation? Criticism is much more spontaneous from the man outside looking in than from the man inside whose life is at stake. Such concessions under

duress imply, of course, a lack of railway unity. If competing roads stood together they could resist. A well-known passage in the New Testament records the confusion amongst accusers when they heard the stern challenge: "Let him who is without sin among you cast the first stone." It is possible that there is an industry or trade in which unity has been attained, so that no concern in it ever sells below cost. If so I do not know of it. For shippers who have not unified their own trades it may be well to speak softly in condemning the railroads for finding like obstacles.

So much for scape goats. After all, what good is a scape goat, either governmental or railway? If rail transportation collapses under the coming boom the shippers will be demanding not excuses or indictments but cars. As practical men they may prudently conclude that no remedy now in sight promises to make willing martyrs of the Interstate Commerce Commissioners, of railway officers now incumbent or coming in, and that if shippers are to insure future rail service by ceasing undue downward pressure on rates they had better not wait to be stopped by somebody else but desist on their own motion, through their own organization and in pursuance of their own enlightened self-interest.

One of my associates has several times advanced a thought as to how the shipper may beguile his eyes from the earth for a periodic gaze at his duty in the zenith. The scheme is for the rate and classification committees to have before them as the docket for one day a month the report of the Bureau of Railway Economics on railway income. Traffic men of the shippers and of the railways would compare the figures with a standard yard stick of adequacy in the public interest and act accordingly in the correction of the rate structure. Either that or some better periodical show-down will accomplish the fundamental purpose. All concerned will have agreed that adequacy of railway income is a national objective. This dogma is a counsel of perfection in which everybody believes but which nobody does anything to realize. The plan would transform it into a rule of practice. The rule of practice will

have been raised from a blue law, dead everywhere except on the statute book, to a daily custom and habit into which the breath of life has been breathed by making specified persons responsible for the show-down at designated times and places. A situation will have been organized in which social stigma to the point of extreme discomfort will descend upon any shipper that shows an inclination to grab an immediate selfish advantage such as would wreck the republic if everyone slacked his self-sacrifice in the same spirit.

Primarily I have in mind that after a way has been found for the railways out of their current crisis, the periodical show-down will prove to be a way to keep them out of crises. It may well be, however, that the announcement of such a plan, adopted and installed, would do more for the immediate restoration of railway credit and for general business recovery than all the measures of government yet proposed, urgently important though some of them are, or than all the progressive activities in which railways may engage to meet the new competition.

COÖRDINATION AS A "WAY-OUT" OF THE TRANSPORTATION CRISIS

By G. LLOYD WILSON

THE present crisis in railroad transportation affairs in the United States is only partially due to the business depression. True this depression with all of its consequences has accentuated the plight of the railroads and brought the deplorable situation to the attention of the public, but the true underlying causes were apparent before the decline in business activity in the late summer of 1929. It is impossible to discuss these causes fully in the short time available but several observations may be noted.

First, railroad freight traffic, as measured by the number of tons of freight originated by Class I Carriers, has not kept pace with the growth of the population of the United States since 1910,

Second, the development of railroad freight traffic has not kept abreast of the increase in railroad facilities,

Third, railroad freight traffic has not reflected the increase in standards of living of the American people in the past quarter century,

Fourth, railroad freight services have failed to reflect adequately the changes in industry, which require greater speed in transportation, greater flexibility of movement and smaller units of freight shipment.

Fifth, railroad passenger traffic has fallen steadily since 1920, reflecting the rise of the passenger automobile and motor bus. The railroads did not meet the demand for cheap passenger transportation services by establishing second class passenger service at reduced rates to meet bus competition.

Sixth, the Federal policy and practices of railroad regulation since the Act to Regulate Commerce of 1887 has been based upon the assumption that the railroads enjoy a domi-

nant position if not a substantial monopoly of inland transportation. This assumption is quite erroneous and should be revised in the light of the present situation.

Seventh, the railroads failed to appreciate fully the importance of the development of motor transportation services and the public demand for these services, in time to make the necessary adjustments in their services and rates to meet this competition,

Eighth, the railroads failed to develop plans of coördinating railroad transportation services with motor transport at the time when the motor carriers first appeared as instrumentalities of commerce when coördination would have been relatively simple and easy to accomplish.

What Is Coördination?

There has been much discussion, during the past ten years, about "coördinated transportation." The terms "coördinated" and "coördination" have been used in so many ways and with such varied implications that there are many confused ideas concerning the meaning of the terms and the objectives of various coördinated transportation plans.

The term "coördination," in the sense in which it is properly used in connection with the transportation system of the United States, has, however, a definite and specific technical meaning. It implies the bringing together of various instrumentalities of transportation, such as railroads, steamship lines, motor bus and motor truck lines and airplane carriers into a harmonious working unity. It includes the regulation and combination of all transportation facilities into unity of action. It proposes the limitation of wasteful and unnecessary competition through the use of each facility in the service in which it is most efficient as parts of a synchronized and integrated transportation system.

The coördination of motor trucks, motor busses, aircraft, steam railroads, electric railways, and steamship lines implies the inclusion of all these carriers into an integrated system of transportation, in which each agency is used in the service in

which it is relatively most efficient, so that by united action, better service may be rendered by each type of carrier, and persons and goods moved with greater economy and dispatch and at lower unit costs to the operators of each service and to those who pay the transportation bills, the users of transportation facilities.

The objective of coördinated transportation for all—the operators of the railroads, the electric railways, the steamship lines, the motor carriers, the air transport carriers, the shippers and receivers of freight, and that important, but all too little considered class, the general public—is the same. In this, as in every other transportation problem of national importance, the interests of all groups are really not in conflict. The objective is the development of adequate transportation services at rates that are fair both to the producers and consumers of transportation services.

The end desired by many to be attained is a national, privately owned, publicly regulated transportation system in which each transportation unit occupies its proper place as determined by its efficiency and economy. The place of each facility should be determined by the relative efficiency with which each does its particular service and not by any artificial rule of prejudice. If it be definitely established that motor trucks haul freight and that motor busses transport passengers in given services more economically than steam railroads, electric railways, or steamship lines, or other carriers, the development of motor transportation in those services should be encouraged, and the facilities of carriers of other types should be devoted to other services in which they are relatively more efficient. To do otherwise is to defy common sense and to ignore the sound principles of economics. A strong economic system is based upon the most efficient utilization of the productive factors.

The Necessity of Coördination

The coördination of various transportation facilities is necessary in order to use the most efficient types of carriers in

services in which they are best fitted; to improve the speed, convenience and quality of transportation services; to diversify the types of transportation services offered; to give the shipping and travelling public the types of services it requires; to improve the relationships among carriers; and to stabilize the financial structures of all kinds of carriers.

Mention only can be made of the far reaching benefits of these forces which impel toward coördination, and of the disadvantages which are inevitable if the various types of carriers regard one another solely as competitors and not as actual or potential coöperators. We have learned through bitter experience that unwise and unregulated competition is ruinous to the carriers, and that it is without permanent benefit to those who for a time receive low rates and duplication of service. In the end the carriers pay for their excesses in competition and the shipping and travelling public suffers from fluctuating rates and inadequate services.

How Coördination May be Effected

Apprehension has been expressed that the coördination of various transportation facilities may result in the domination of one type of carrier over all others and the stultification of the natural developments of the coördinated carriers. There is no valid basis for this apprehension provided the public continues to demand diversified forms of freight and passenger service and so long as the state and federal transportation regulatory policies are comprehensive and constructive. Each type of carrier must be used in the service to which it is best suited; the public must be given the kinds of service it requires—whether all-rail, all-water, all-highway, all-air, or combinations of these facilities; and the state and federal governments must regulate the services and rates of all carriers and all combination services and rate arrangements in the best interests of the carriers and the public.

Coördination in its correct sense can be achieved through:

1. The ownership and operation of various types of transportation facilities by single companies offering several kinds of services—rail, steamship, motor and air, or,

2. The organization of subsidiary companies by the larger carriers such as the railroads, steamship lines or electric railways, to own and operate other facilities such as motor busses, motor trucks or airplanes, or,
3. The establishment of agency arrangements under the terms of which the railroads, steamship companies or other transportation companies employ independent contractors to perform certain services, or,
4. The establishment of joint service, rate and route arrangements by independent coöperating carriers—railroad, steamship, motor or air.

The Present Status of Coördination

Great progress has been made in coördinating and integrating transportation services since the World War and especially in the past several trying years in the transportation business.

A few representative types of coördination may be mentioned to illustrate the progress that has been made:

1. The establishment of extensive joint rail-ocean; rail-lake, and rail-inland waterway services.
2. The use of joint rail and motor bus services in both the short-haul and long-distance fields.
3. The development of the joint use of motor trucks in station-to-station services, in terminal services and in certain long haul services by combination rail, steamship and motor arrangements.
4. The inauguration of joint rail-and-airplane services for the transportation of passenger, mail matter and express traffic.
5. The combination of electric railway and motor truck and motor bus services, and,
6. The use of interchangeable containers, sectional cars, or other devices for the transportation of freight in unbroken lots via joint rail-and-motor or rail-steamship-and-motor routes.

Instances of double and triple coördinated facilities such as rail-and-motor or rail-steamship-and-motor are steadily growing and will doubtless continue to expand as the benefits of coördination become more fully appreciated by the carriers and by shippers and travellers.

What are the advantages of coördination?

To the carriers, coördinated transportation means:

1. Reduced costs of operation, especially on branch lines where traffic is light.
2. More flexible use of facilities in terminal and station-to-station services.
3. Reduced congestion in the terminals.
4. Through rate, route and interchange facilities.
5. Faster movements of freight and passenger traffic.
6. Elimination of extra handlings of freight, and transfer of passengers.
7. Reduction of unwise competition and duplication of services, and,
8. Elimination of uneconomical transportation services by one type of carrier and the substitution of another.

To shippers and travellers coördination means:

1. Through routes at through rates or fares,
2. Through joint bill of lading and ticket arrangements,
3. Centralized responsibility for the safe carriage of passengers and property.
4. Schedules so adjusted as to facilitate through shipment or travel over the lines of several transportation agencies,
5. Lower rates and fares consistent with the class of service offered.
6. Fewer loss, damage and delay claims,
7. Easter movement of goods and persons, and,
8. More convenient means of shipment and travel.

There is little doubt that the ultimate goal of all coördinated transportation services is the door-to-door movement of passengers by combinations of motor-rail-steamship-air-carriers under through ticket arrangements and at through rates; and the store-door to store-door movement of freight over coördinated routes, so that it will become as easy to travel long distances over a number of common carriers of various types as it is to travel from one's home to a friend's home in a private automobile, or as easy to ship freight by combinations of several types of carriers as it is to mail a letter.

The Future of Coördination

Coördination is an evolutionary process. It must be developed slowly and surely in order to conserve the revenues of the carriers, to insure continuity of service and to prevent violent disruptions of business arrangements and relationships.

1. The public must know more of the benefits of coördination,
2. The proprietors of services to be coordinated must be treated fairly in making further arrangements for coördinated services,
3. The services and rates of all carriers must be made subject to impartial and constructive regulation, and
4. Legislation must be enacted to foster and assist in the development of coördination and to permit the substitution of one sort of transportation facility for another, subject to the approval of the governmental regulatory bodies.

The trend toward coördination has proceeded to the point that we can predict that the great railroads, steamship companies, electric railways and other specialized carriers will tend to become *transportation* companies rather than exclusively railroad or steamship or electric railway companies offering a variety of transportation services to shippers and travellers that will supply the needs and fit the pocketbooks of their patrons.

There have been many significant evidences of the trend toward coördination in transportation services and facilities and the possibility of the emergency of great transportation systems supplying all types of transport services.

The further development and prosperity of the United States requires transportation facilities and services of many kinds and the coördination of transportation by railroad, waterway, highway, and airway.

The coördination of transportation facilities will tend to eliminate wasteful competition, which in the past has been harmful to all types of carriers. Wasteful competition is not in the best interest of the public and its elimination will be a milestone in transportation progress. The services of all types of carriers must be integrated through the establishment

of joint routes, joint rates, free interchange and continuous responsibility, if the best interests of the various types of carriers are to be conserved, and if the public is to be adequately served. No carrier must be artificially or unduly restricted, but each must be used where it fits most efficiently in the transportation "jig-saw puzzle." Both "wholesale" and "retail" types of carriers must be developed and their services integrated and coördinated.

FRANCIS X. DERCUM

By ALBERT P. BRUBAKER

(*Read March 4, 1932*)

Dr. Francis X. Dercum, the late President of the American Philosophical Society was a distinguished physician and neurologist of Philadelphia and highly esteemed and honored by his colleagues at home and abroad. He was also a student of Biology and deeply interested in many of its problems partly for their intrinsic value and partly for the light thrown, by their solution, on the phenomena of the human body both in health and disease. Neurology and biology were his two major interests.

Dr. Francis X. Dercum, a native of Philadelphia was born August 10, 1856. He was the son of Ernest Albert and Susanna Erhart Dercum. He was a descendant of a line of European ancestors many of whom were distinguished as lawyers, judges, scholars, scientists and physicians. Two of these ancestors occupied professorial chairs in the University of Würzburg in Germany. It might be expected coming from such an ancestry that he would inherit some of the traits that characterized and distinguished his predecessors "His forebears of old." Dr. Dercum's grandfather and father came from Germany. They immigrated to this country in consequence of the failure of the revolutionary movement in 1848 to obtain a more liberalized form of government and with the leaders of which they had been sympathetically allied. Dr. Dercum's early education was received primarily in the public schools of Philadelphia and secondarily in the Central High School, the foster mother of many of the distinguished professional men of this City. From this institution he was graduated in 1873, and which later conferred upon him the degree of M.A.

In obedience very probably to an inherited instinct he resolved to study medicine and with this end in view he entered the Medical Department of the University of Pennsylvania in 1874 and from which he was graduated in 1877.

So zealous and assiduous was the young student in the acquisition of knowledge that the University conferred upon him the degree of Ph.D., after an intensive study of the Sciences in the postgraduate summer school. After his graduation he opened an office thinking himself in all probability prepared to engage in the practice of medicine. While waiting for patients which proverbially are slow to appreciate the merits and qualifications of a recent graduate, his mind reverted to the instruction of his university professors especially to that great human and comparative anatomist Dr. Joseph Leidy, who impressed upon him not only a knowledge of the anatomy of the human body but a corresponding knowledge of the anatomy of typical forms of the vertebrate series of animals. From Professor Leidy he received not only that wide view of the unity of organization of vertebrate animals disclosed by a comparison of their structure, their similarities and dissimilarities but also a love for the biological sciences and an appreciation of the value of the comparative method in the study of the nervous system more especially. This method was of inestimable service to Dr. Dercum in the years that were to follow. While waiting for patients, Dr. Dercum had many opportunities for reflecting over the problems of comparative anatomy. As a result he prepared two papers, one entitled "On the Sensory Organs, Suggestions with a View to Generalizations"; the other, entitled, "The Morphology of the Semicircular Canals," both of which were published in *The American Naturalist*, the first in 1878 the second in 1879.

In 1878 Dr. Dercum was elected a member of the Academy of Natural Sciences where he established personal relationships with Leidy, Cope, Ryder, Parker, Chapman and many others by whom his scientific inclinations were strengthened and developed. In the first year of his membership he

prepared and read a paper entitled "The Morphology of the Lateral Lines in Fishes," which was subsequently published in the Proceedings of the Academy in 1881.

It was at this time that he made the acquaintance of that gifted and promising anatomist Dr. Andrew J. Parker who was devoting himself to the study of the morphology of the brain with especial reference to the cerebral convolutions not only of man but of the anthropoid apes as well. This subject was attracting the attention of anatomists almost everywhere for the reason that experimental physiologists and clinicians had apparently demonstrated an intimate physical and functional connection between groups of nerve cells of the cerebral cortex and the skeletal muscles on the one hand, and between the sense organs and specialized groups of nerve cells of the cortex on the other hand. As stimulation of the former groups gave rise to muscle movements, and destruction by experimental procedures or disease was followed by a loss of movement or paralysis, they were termed motor centers. As stimulation of the latter group by way of their related sense organs gave rise to sensations, and their destruction by experimental procedures or disease was followed by a loss of sensations peculiar to the sense organs they were termed sensor centers. Both groups of cells came to be regarded as the physical bases of motor and sensor functions. The bearing of these facts on normal and abnormal conditions of the entire nervous system and its associated organs at once became apparent. Hence it was that the study of the convolutions, their general form, their relations and microscopic structure enlisted the attention and interest of anatomists and neurologists wherever these sciences were cultivated. The friendship of these two young men which lasted until the untimely death of Dr. Parker, and their mutual interests in the study of the brain, awakened in Dr. Dercum so deep an interest in neurological science that Horatio C. Wood, Professor of Nervous and Mental Diseases in the University of Pennsylvania urged him to devote himself to the study of the diseases of the nervous system. This good suggestion was

promptly accepted and conscientiously followed. He was at once in 1883 appointed Chief of the dispensary for nervous diseases, and instructor of nervous diseases in the Medical School of the University, two positions which he held for almost ten years. With the acceptance of these positions his strictly scientific investigations terminated. In 1887 Dr. Dercum was appointed Neurologist to the Philadelphia Hospital, a position he occupied for 20 years. The dispensary service of the Medical School and the neurological wards of the Philadelphia Hospital were rich in patients who collectively presented so many forms of nervous diseases, that the time and energy of Dr. Dercum were almost wholly occupied with their study and treatment. Under the stimulating influence and example of Professor H. C. Wood, his interest in and enthusiasm for both nervous and mental diseases increased with his years and as a result he acquired that profound knowledge of his specialty that distinguished him in his subsequent career. Clinical investigations and diagnostic ability were supplemented by a strictly scientific study of the anatomy and physiology of the nervous system both in health and disease.

In 1884 Dr. Dercum in association with Drs. Charles K. Mills, Wharton Sinkler, J. T. Eskridge and others, realized that the relatively new Science of Neurology would be advanced if the neurological students of Philadelphia were given the opportunity to coöperate both in investigations and discussions. For this purpose the Philadelphia Neurological Society was organized, a Society which has had a distinguished career for now forty-seven years. At the meetings of this Society Dr. Dercum presented from time to time a series of papers which enlisted the interest and attention of its members. As a member and subsequently as President, he contributed to the success of its ideals.

During the ten years of his activity in these institutions his alert and active mind observed a great variety of new and strange facts presented by patients with abnormal conditions of the nervous system and the body in general. These facts

carefully observed and analyzed formed the subject matter of thirty or more papers written alone or in conjunction with colleagues and which were subsequently published in various medical journals of a general or special character. These contributions to neurological science embraced a wide range of topics, the mere enumeration of which would be out of place in a Memoir of this character especially as their titles are for the most part of a strictly technical character. That they were of sufficient merit to attract the attention of the leading neurologists of the country is apparent from the fact of his admission in 1886 to membership in the American Neurological Association. His interest in the work of this association and his contributions to its annual meetings were highly appreciated, and were rewarded by his associates who elected him Vice-president in 1894–1895, President in 1896 and Councillor in 1897, 1899 and 1905.

In 1892 the Jefferson Medical College created a chair of Nervous and Mental Diseases to which Dr. Dercum was appointed with a seat in the Faculty. This position involved not only the delivery of a systematic course of lectures throughout the academic year but a series of clinical lectures, illustrated by well-selected cases provided by the large and well-organized dispensary service which he founded and developed. In this work he was aided by a large and loyal staff of assistants who contributed in various ways to make the department of nervous and mental diseases a distinguishing feature of the educational work of the Jefferson Medical College. In this field of professional activity Professor Dercum served the Jefferson Medical College with great distinction for a period of thirty-three years, when he tendered his resignation in the Spring of 1925 much to the regret of the Trustees, the faculty and the student body. Having completed a long, honorable and successful career, he was honored with the unofficial title, Emeritus Professor, which he retained until the day of his death. As a lecturer and teacher, Professor Dercum developed an art of presentation the result of an accurate knowledge of his subject which

made him acceptable and instructive to students. His lucidity of statement, his enthusiastic and pleasing delivery won for him unlimited success. The class of 1911 placed on record the general opinion of the student-body in the following words, "Frankness, friendliness, and kindly recognition of the difficulties of his subject and his endeavor to render it less arduous have won for him a place in the heart of every student who has been so fortunate as to come under his tutelage."

By virtue of his knowledge, his acute and logical mind Dr. Dercum was called upon on numerous occasions to testify in the courts of Philadelphia and elsewhere in medico-legal cases in which questions of insanity and other forms of nervous disease were to be considered and judicially decided. So reliable and accurate were his analyses and decisions that he enjoyed for many years an enviable reputation as an expert witness.

The same qualities of mind enabled him to unravel the complex phenomena frequently presented by organic diseases of the nervous system and to determine the location and actual condition of the structures involved. For this reason Dr. Dercum's services as a consultant were much sought after by his professional friends. It was in the capacity of a diagnostic expert that he was called upon from time to time by the neurologists attending President Woodrow Wilson in his long and fatal illness.

Notwithstanding the ever increasing cares and responsibilities of his steadily developing private practice and consultation work, Professor Dercum found time to contribute to neurological science the results of his observations and investigations of nervous and mental diseases. His assiduity in literary work was truly remarkable. The record of his published papers alone during the years from 1892 to 1919 numbers approximately one hundred and seventy titles.

One of the most significant of these papers, published in 1902 was a description of a disorder of nutrition which attracted and still attracts the attention of neurologists.

Though some of the individual features of this disorder had doubtless been seen by other clinicians their significance had not been appreciated. It remained for Dr. Dercum to collate and group all the observed features as presented by different patients, to point out their relation one to another and thus give to the group a distinct entity.

The chief features of this nutritional disorder are large irregular cushion-like deposits of fat in different regions of the body which are painful on pressure, and associated with muscular weakness, ready exhaustion and certain psychic phenomena, as depression, slowness, neurasthenia, hysteria, etc.; to this combination of symptoms Dr. Dercum gave the name Adiposis dolorosa. Subsequently French writers gave to the disease, in honor of its discoverer the name "Maladie de Dercum"—in English speaking countries it is generally referred to as Dercum's disease. The causation has been attributed in recent years to disorders of endocrine organs, more especially to the pituitary.

In the course of his professional life Dr. Dercum was highly honored for his character and achievements by his colleagues at home and in foreign countries.

Thus he was elected a member of the Academy of Natural Sciences of Philadelphia in 1878; Fellow of the College of Physicians of Philadelphia in 1885; member of the American Philosophical Society in 1892; President of the American Neurological Association in 1896; President of the Philadelphia Neurological Society for two years; President of the Psychiatric Society for one year; Member of the American College of Physicians in 1923.

He was also elected a member of the following foreign societies: The Société de Neurologie de Paris, 1908; the Royal Medical Society of Budapest, 1909; the neurological section of the Royal Society of Medicine of London; the Psychiatric and Neurological Society of Vienna, 1911; the Society of Physicians of Vienna, 1921. He was decorated Chevalier of the French Legion of Honor, 1923.

As final illustrations of Dr. Dercum's intellectual activity

may be mentioned the following works relating to Neurology and allied topics which were prepared during his professional career.

Edited a Text Book of Nervous Diseases by American authors, 1895, pp. 1056; Rest, Suggestion, and Other Therapeutic Measures in Nervous and Mental Diseases, 1917, pp. 395; Clinical Manual of Mental Diseases, 1913, 2d edition, 1917, 425 pp.; Hysteria and accident Compensation; Nature of Hysteria and the lesson of the post-litigation results, 1916, 120 pp.; The Physiology of Mind, an interpretation based on biological, morphological, physical, and chemical considerations, 1922, 2d edition, 1925, pp. 287; Biology of the Internal Secretions, 1924, pp. 241.

In 1892 Dr. Dercum married Elizabeth De Haven Comly, a member of an old Philadelphia family. Mrs. Dercum and two daughters, Mrs. Samuel W. Mifflin and Miss Mary De Haven Dercum, survive.

As previously stated Dr. Dercum resigned his professorial duties in June 1925 with the view of devoting himself to the study of biological problems which had occupied his attention during leisure hours for many years. A few months previous to this time however Dr. Charles D. Walcott and Dr. Dercum had been elected President and Vice-President respectively of the American Philosophical Society both of whom had been members for many years.

In 1927 February 9, the distinguished President of the Society Dr. Walcott unexpectedly died much to the regret of the members generally as his death was regarded as a distinct loss to the interests of the Society.

At the Annual Meeting of the Society held April 1927 Dr. Dercum was chosen by the members to succeed Dr. Walcott as President. This great honor was profoundly appreciated and for four years, to the hour of his death he performed the duties incidental to the office with distinction and with great benefit to the Society.

Surveying his achievements during the four years of his presidency the most striking was his successful effort in

raising the necessary funds for the erection of a new, more suitable and commodious building for the Society which the passing of the years, the growth of the library, the shifting of the population seemed to make most desirable.

For some years the members of the Society had entertained a dream of a new home for the Society in which could be housed, in absolute safety the extensive collection of priceless relics of the builders of this nation, the valuable portraits and busts of its Presidents and many of its members, the rare historical letters and manuscripts, the thousands of old and many irreplaceable historical volumes of the library, all of which are among the cherished possessions of the Society. For years it had been apparent that a Society for promoting useful knowledge owed it to scholarly research to provide increased facilities for readers and research students of the early history of our nation. But alas! the means for accomplishing this desirable end were wanting.

Very shortly after Doctor Dercum's election to the Presidency he inaugurated and directed in conjunction with his associates the movement which resulted in the securing of a fund sufficient to transmute the vague long-cherished dream into a rapidly-approaching reality. There can be no doubt that in so doing he initiated a new era in the life of the American Philosophical Society.

The current affairs of the Society received his constant attention and enlisted his active interest. By unceasing personal effort he brought to the meetings eminent scholars as speakers and auditors. As a result, the meetings increased in interest and significance. He himself contributed four papers to the Proceedings of the Society, viz.: "The Origin and Activities of the American Philosophical Society," "The Dynamic Factor in Evolution," "On the Nature of Thought and its Limitation" and "Non-Living and Living Matter."

Death came suddenly to him, seated in Benjamin Franklin's chair, as he presided over the first session of the General Meeting of the Society for 1931. Surrounded by many of his scientific colleagues and friends and the portraits of many of

America's great men who had bequeathed this Society to successive generations, he had just spoken concerning the progress and the ambitions which the Society entertains and expressed the belief that these ambitions had every prospect of being realized. It seemed to be his bequest to the present generation. His memory will be gratefully and affectionately cherished.

UNEMPLOYMENT INSURANCE

By S. S. HUEBNER

(*Read March 4, 1932*)

ACCORDING to Thomas Carlyle "a man willing to work and unable to find work is perhaps the saddest sight that fortune's inequality exhibits under the sun." Carlyle was correct in emphasizing the words "willing to work" and "unable to find work." These two concepts of "willingness" and "inability to find" constitute the very basis of correct reasoning concerning unemployment in so far as Insurance can be of service. Insurance cannot be made to relate to those who cannot work or to those who, as has been well said, "live in hope, hoping that by doing nothing there will be nothing to do."

NATURE AND EXTENT OF THE RISK

The basic causes of unemployment are six in number; and may be stated briefly as follows:

1. *Physical, Mental or Moral Disqualification.*—This group is quite numerous and, like the poor, we shall always have it with us. On the border line, this group is often greatly augmented during slack times by those who are on the last rung of the ladder of competency, owing to poor training or general inaptitude. They constitute an important class of drifters, somewhat willing but not wanted, and are thus the first to be dispensed with when the labor market becomes slightly glutted. The whole group presents more or less a persistent and at times a chronic unemployment problem.

2. *Habitual Disinclination to Work.*—This group is also a substantial one. Although capable of work, this group is subnormal from the standpoints of economic desire and personal or family dignity. It looks to charitable relief as the easiest

course. Instead of giving such relief, however, we might well inquire if more strenuous measures might not prove socially more just and efficacious.

3. *Industrial Disputes, Such as Strikes and Lockouts.*—They usually occur during periods of prosperity and are rarely unavoidable. They are nearly always the result of deliberate action. They are man-made and not fortuitous.

4. *Seasonal Unemployment.*—This type involves industries or callings which experience unemployment regularly during certain portions of the year. A few illustrations, of the many which might be cited, are building construction, clothing manufacturing, canning, logging, coal mining, ice harvesting and agriculture.

5. *Technological Displacement.*—Unemployment under this heading results from a multitude of factors, such as displacement by labor-saving machinery, displacement of an entire business by the development of a new commodity serving better as a substitute for the old, loss of markets not occasioned by a general business depression, changes in fashions, unwise overexpansion of an industry, improved organization of plant, and consolidation of business concerns. Although not able to be forecast as to nature and extent, such changes may be expected as a regular thing in a progressive world, and constitute a persistent problem to be reckoned with even in times of prosperity. Despite the huge production of the peak years of 1928 and 1929, there was nevertheless a very noticeable tendency towards increased unemployment resulting from technological changes. Labor was more and more displaced through machinery, efficient business methods, and a consolidation of enterprises, at a rate in excess of the possibility of absorbing the resulting unemployment in new business enterprises, such as were afforded by the radio, the automobile, and air craft construction and transportation.

6. *Depressional or Cyclical Convulsions.*—Business depressions constitute by far the most serious aspect of the unemployment insurance problem. They furnish the dramatic

side of unemployment, when huge numbers, "willing to work and unable to find work," find themselves and their families deprived of the means of a livelihood. Often the number becomes so large as to foreshadow menacing radicalism for the community. Since the year 1800 we have had 18 of these business depressions, and at intervals of about every twenty to thirty years we experience an unusually severe one, like those of 1840–44, 1873–79, 1893–97, and the one we are in now, beginning in October of 1929 and extending to the present. Business convulsions occur at more or less regular intervals, on the average of about one each seven or eight years. Each time our sympathy is thoroughly aroused for the unfortunates in need. Prior to the present crisis, we depended on the "bread line" and to charity in a more or less unorganized fashion. This time we are proceeding along more clear-cut lines of organized relief. But in the last analysis it is still charity, and charity does not appeal to red-blooded people with a fair sense of pride who are willing to work but unable to find a source of earnings. However, in our present predicament, we are at least discussing unemployment insurance, and in some quarters most volubly. Insurance has made sufficient headway in the public mind to be recognized as the only sensible, dignified way of meeting the adverse consequences resulting from hazards associated with our economic life. Its mission is that of "risk bearing" and "risk elimination." It represents the process of levelling the years of human productivity in the interest of financial stability, and seeks to do this in an orderly, convenient and scientific way. Its mission is to equalize things by taking the accumulations of the prosperous (fat) years, and making them available during the depression (lean) years, so that there may be no want or economic suffering.

Of the aforementioned six basic causes of unemployment, the first three—physical, mental or moral disqualification, habitual disinclination to work, and industrial disputes—must be excluded from any plan of unemployment insurance which is to have any regard for solvency or practicability. In

Insurance language they are either deliberately man-made or represent "inherent vice" in the subject matter of the insurance. Their inclusion would necessarily mean a prohibitive premium and ultimately bankruptcy to any insurance fund. Aid to these groups, and more particularly with reference to the first two, is in its very nature a community affair, and partakes of the nature of "relief" from the public treasury or from charity, rather than insurance through a fund created by contributions either from employers or employees or from both. The last three causes of unemployment, however—seasonal, technological and depressional unemployment—are of a totally different nature. Here we may well inquire into the applicability of the insurance method, based upon the accumulation of a fund from the contributions of those who are directly interested. By applying rigidly proper limitations as indicated by experience, which will be referred to later, we may hope to find that insurance can serve to a substantial extent. Even though Unemployment Insurance may never be so scientific in its application as are Life, Fire, Marine, Corporate Bonding, and the other commonly used forms of Insurance, and even though it may never be able to guarantee a coverage nearly so complete as do these other forms of Insurance, yet we may hope that it can be made to cover to at least a substantial degree and thus be an improvement over existing conditions.

This cautious statement is made because of the stupendous extent of the risk involved. All of the hazards now commonly insured against, such as death, accident, sickness, fire, marine disaster, embezzlement, failure of contractors, public damage liability, etc., are child's play in comparison with the unemployment hazard, as defined under the last three types of causes. The various forms of Insurance mentioned operate on a reasonably reliable statistical basis, whereas unemployment statistics are largely imperfect or wanting, and even if collated to-day could not inspire confidence with respect to the future. The landslides are enormous every seven or eight years, and sometimes these mass catastrophies are

much greater than at other times. The nearest approach is the conflagration hazard in Fire Insurance. But what is the largest conflagration in American History—the San Francisco conflagration involving a loss of $300,000,000—in comparison with the unemployment loss hazard of the present period, extending over so many millions of workers and enduring for so long a period of time. We were informed recently that over eight million persons are now out of work in the United States, and probably three-fourths of this number fall within the last three types of causes mentioned, particularly the last one. The unemployment problem is extending to all walks of life, not merely to industries, but also to the professions, governmental departments, schools and even universities. In its recent report the Wisconsin Legislative Committee on Unemployment estimated that in manufacturing alone there were 78,840 fewer employees in that one state in September 1931 than in September 1929. According to the figures of the New York State Department of Labor the percentage of the employed in manufacturing establishments in New York State had declined by 26 per cent between September 1929 and September 1931. Moreover, since business depressions follow immediately after the height of prosperity, the avalanche of unemployment usually follows suddenly the period of greatest employment. Again, although admitting that depressional unemployment is the most serious because the unemployment is so long and comes in such an avalanche, the Wisconsin Commission observes that "if we consider the last decade, it is probable that the other types of unemployment have caused more loss of time than depressional unemployment."

But even assuming that the unemployment hazard could be predicted within reasonable limits, and that it did not from time to time strike simultaneously an extraordinarily large portion of the entire insured group—two very important essentials in any scientific program of insurance—there are still further reasons for caution. Insurance is predicated upon the condition that the contingency insured against be capable

of reasonably certain verification so that the claim may be legitimate and not unjust to others in the insurance arrangement. No doubt this condition is capable of ultimate solution through coöperation of the employer. But for the time being the moral hazard would seem to loom large in Unemployment Insurance, as compared with the commonly used forms of insurance. Moreover, in probably no other form of insurance, since we are dealing almost exclusively with human psychology in its relation to human toil, is there so much need for the exercise of extreme care so that the bad may not be bred out of our striving for the good.

Right of Employees to Insurance Protection

In one sense most of the forms of Insurance now in general use are Unemployment Insurance. Many of the various types of Property Insurance, in the forms of Use and Occupancy Insurance, exist to protect property against unemployment. Should the property either be destroyed or disabled, and therefore no longer able to work, they serve the function of Unemployment Insurance. Accident and Health Insurance exist to pay for the loss of working time when occasioned by accident or sickness. Similarly Life Insurance is also Unemployment Insurance. It aims to protect against unemployment on the part of members of the household who cannot work or ought not to work, should the family head be removed by death. It aims to protect the insured while he lives (with a savings accumulation known as the "cash value" of the contract) should he become unemployed through accident, sickness or the loss of his position. Again, its purpose is to protect the insured, through the same cash value of his contract, against unemployment when the age of retirement is reached and when by the law of nature he must cease to be actively employed in economic affairs.

Business is a judicious union of property values and life values, and either may become unemployed. Stated in another way, business consists of two personal elements. One is the owner of the working capital which may become

partially or totally unemployed, and may be called the owner or dividend receiver. The other is the employee, the wage or salary receiver, who may lose his compensation in whole or in part through unemployment. With respect to the dividend receiver we have practiced the insurance idea under private auspices for many years. No business management is regarded as wise which does not retain out of current earnings at least 30 or 40 per cent during the fat, prosperous years in order to stabilize and regularize dividends during the lean depression periods which are presumed to come from time to time. This practice is called surplus accumulation, and represents the setting up of an insurance fund to level to the owners the yearly income of prosperous and unfavorable periods.

Stockholders are not all affluent or unworthy of consideration. Of the fifteen million or more stockholders in the United States, the great majority are in humble circumstances. There are any number, dependent upon income, who are old and incapable of working any longer. Many are orphans and dependents provided for through investments in trust estates. Of the 241,000 stockholders of the Pennsylvania Railroad over one-third are said to be women. In fact, there are many stockholders in a more defenseless position than is the able-bodied worker who happens to be out of a job. It seems a cruel thing to cut off the income from such persons, and there is therefore need for insurance to protect against unemployment of the capital, *i.e.* for dividend insurance.

It is providential that the managers of so many of the corporations whose securities are listed on our stock exchanges used the prosperous years to pile up huge surpluses in order to take care of a period such as we are now going through. The only business barometer that did not show up badly by the close of the third quarter of 1931, out of all the business barometers published, was the one which recorded the dividend distributions of corporations listed on the New York Stock Exchange. During the first ten months of 1931, the latest for which I have figures, the dividend distributions for all

industrial corporations listed on the New York Stock Exchange, were only 12 per cent under the dividend distributions for the corresponding ten months of 1930, and those for 1930 exceeded those of 1929, the banner year of prosperity. For all the railroad and traction companies listed on the New York Stock Exchange, dividend distributions during the first ten months of 1931 were only 10 per cent under the similar distributions of 1930, and that year also exceeded in this respect the prosperity year of 1929. During the latter part of 1931, after one and a half years of withering depression, dividend cuts became numerous and drastic because insurance funds began to run unduly low or the managers of business feared the length of the depression. The dividend insurance scheme, in other words, has not proved perfect, but it has, to the extent of the lasting quality of the accumulation, proved beneficial to the owners or dividend receivers. They contributed to the fund with that portion of their earnings which the managers retained during the fat years, and received the same back in substantial measure in deferred payments during the lean years.

Now if business does this for the dividend receivers, as a matter of common-sense management, why should not something of a similar nature be done for the worker, the wage and salary receiver? He is a part of business just as much as is the owner. He represents the human element in business, whereas the dividend receiver represents the property or capital element. He is entitled to the protection of a plan which will regularize his income to some extent between prosperous and depression periods, just as the dividend receiver already has had his income regularized to a substantial extent. And if a part of the dividend receivers' earnings are retained for the accumulation of an insurance fund during prosperous years, we may well ask why a portion of the workers' earnings should not be retained for the same purpose. If private business fails to recognize the fairness of this proposition, it will erelong experience a fine dose of compulsory government Unemployment Insurance.

For the present we must grope along as best we can with charity, both organized and unorganized, because we have made precious little provision along non-charity lines. The future requires that we learn our lesson in this depression, and proceed promptly with the beginnings of recovery to accumulate funds during the next period of prosperity for distribution during the following period of business convulsion. The less we enthuse in new era ideas the better. Business depressions are a phenomenon which will remain with us for many years to come. In fact such depressions are occurring more frequently now than they did fifty or a hundred years ago. Employees willing to work are entitled to some consideration, and that soon, by those who are the leaders of business. Employees have a desire for reasonable security and a wish for freedom from the paralyzing influence of fear, just as much as do the employers. We must recognize that more and more this nation's former condition of independent occupations is being transformed into one of employment for hire. When deprived of gainful work, the employee loses not only the necessities of life for himself and his family but where there has been some effort at thrift, his limited savings, "his best weapon for the conquest of fear" as has been well said, and also even his home by foreclosure.

Summary of Plans in Use

All the world seems to be groping for feasible plans of Unemployment Insurance. Among leading nations least seems to have been done in the United States, probably because of our greater prosperity, but even here the subject is now receiving constant and extensive attention. In 1931 eighteen countries had adopted Unemployment Insurance plans,[1] namely Australia (Queensland), Austria, Belgium, Bulgaria, Czecho-Slovakia, Denmark, Finland, France, Germany, Great Britain, Irish Free State, Italy, Netherlands, Norway, Poland, Russia, Spain and Switzerland. In nine of

[1] For a detailed account of the Unemployment Insurance plans of these countries see the compilation prepared by the Metropolitan Life Insurance Company.

these countries the plan is compulsory, namely in Australia, Austria, Bulgaria, Germany, Great Britain, Irish Free State, Italy, Poland and Russia, whereas in the remainder it is voluntary. All sorts of differences prevail in these numerous plans. In a general way, however, it may be stated that the compulsory plans cover a larger proportion of the total working population, and require in all but two cases (Russia, where the employees are exempt from contributions, and Italy where the State is exempt) contributions from employer, employee and the State. The voluntary plans, on the other hand, with the exception of Denmark where the employer must contribute, require contributions only from the employee and the State.

Of the various governmental plans those of Great Britain and Germany have commanded greatest interest. The British plan, first adopted in 1911, is said to be the first national compulsory Unemployment Insurance Act ever to be adopted by any government. Originally only a limited number of insured trades were covered, representing a total of about 2,250,000 insured workers. But since that time the scope of the plan has been enlarged to include practically all trades (except agriculture and private domestics) and covers in all about 13,300,000 wage earners. Originally the contribution was about 14 cts. a week, to furnish a weekly benefit of $1.70 per week, following a waiting period of one week, and extending for a maximum duration of 15 weeks in any year. Subsequent changes have increased the premium charge to about 45 cts. per week for adults, the contribution being about 16 cts. for the employer, 14 cts. for the employee, and 15 cts. for the State. At present the claimant must have made thirty contributions in the last two years, must be capable and available for work, and must not have refused an offer of suitable employment or to carry out directions to help him find it. Benefits are now payable throughout the length of unemployment (*i.e.* without any time limit) and the weekly amount received has been materially increased, to about $4.14 for adult male workers.

Owing to the business activity of the war years, the British fund at one time succeeded in accumulating a surplus of about $100,000,000. Even as late as 1922 it remained in a solvent condition. But since that time the fund has undergone an extraordinary depletion, thus indicating the extreme importance of a depression period in Unemployment Insurance matters. Between November 8, 1920, and October 25, 1930, the British Unemployment Insurance plan has cost by way of contributions a total of $2,166,065,000, of which the Government contributed $657,450,000. In addition the Government extended loans to the fund of $257,924,500. Moreover, for "out of work donations," not coming within the scope of the fund, the Government has paid another $300,000,000.

The German system, first adopted in 1927, differs from the British system in three main particulars. Whereas all workers under the British system must pay a flat premium and receive flat benefits, irrespective of the wage received, *i.e.* are all equals, Germany makes the contributions as well as the benefits received a percentage of the wage or salary. As regards the waiting period (two weeks) and most other restrictions, the German system is also more severe. Originally the German plan also excluded the State as a contributor, but later it was found necessary for the Federal Budget to subsidize the fund to the extent of one-half of the annual deficit. Germany evidently made every effort to avoid the apparent mistakes of the British system. Yet with all of the British experience before it, the German plan has also run into a serious deficit, and the Government has found it necessary to finance one-half of the same, increased contributions and reduced benefits being relied upon to meet the other half.

In the United States only a very limited Unemployment Insurance experience can be pointed to, all existing plans covering probably not more than 200,000 workers. Three types of plans have been used, namely (1) union unemployment benefits, (2) joint agreements between unions and employers, and (3) private company plans. The union plans,

found mostly in the printing trades, usually provided for the accumulation of a fund from definite contributions or special assessments from the members, and give benefits ranging from $4 to $25 a week (following a stipulated waiting period) for a limited number of weeks (like five weeks) in any year.

The joint employer-employee agreements exist in certain strongly organized trades. Under the agreement between the Amalgamated Clothing Workers of America and the firms comprising the Chicago market, employers contribute 3 per cent of the payroll and employees 1½ per cent. The benefits amount to 30 per cent of full-time earnings up to $15 a week for nearly four weeks in each season. It is reported that over $5,500,000 have been distributed under the plan thus far. The Rochester Agreement has also aroused much attention. Here a number of Rochester industries—including such important firms as the Eastman Kodak Company, the Rochester Telephone Company, and the Consolidated Machine Tool Company—have united to grant unemployment relief in their own industries. Employers make all the contributions, these amounting to 2 per cent of the payroll until the total reserve amounts to five annual contributions. Employees contribute only in the event of an emergency when they are asked to contribute 1 per cent of the payroll, the employer's contribution also being increased by a similar amount. Employees may receive benefits after one year's service, if earning less than $50 a week, to the extent of 60 per cent of normal pay with a maximum weekly limit of $22.50.

Of the private company plans, that of the General Electric Company (started in June 1930) is by far the largest. It is voluntary as regards participation by the employees, yet approximately 35,000 employees have been contributing at the rate of 1 per cent of actual weekly or monthly earnings. The Company's contribution to the fund is equal to that contributed by the employees. Should it happen that unemployment or part-time work among contributing employees becomes so great as to require 2 per cent or more of average earnings of contributing employees to be paid from the fund,

all employees including even the highest officers of the Company (whether entitled to unemployment payments or not), earning in excess of 50 per cent of their average full-time wages or salaries, are obliged to contribute at the rate of 1 per cent of earnings, the Company contributing an equal amount. All funds have been placed in trust at a guaranteed annual interest rate of 5 per cent. As regards the benefits, a waiting period of two weeks is provided for, and thereafter the unemployed receive 50 per cent of average earnings, but not to exceed a maximum of $20 per week for ten weeks in any year.

Recently the State of Wisconsin adopted an Unemployment Reserve Law, providing for contributions solely from the employer, who under the Act is responsible only for his employees. Employers are required to contribute 2 per cent of the payroll until a reserve of $55 per eligible employee has been established, after which the contribution is 1 per cent until the reserve per employee equals $75. Thereafter the employer's contributions cease, and the fund may be augmented only through voluntary contributions from the employees. Persons with salaries of $1500 or more, as well as railroad workers, teachers, part-time employees, substitute workers, domestic help, farm laborers, workers in the logging and lumber industries, and various other groups are exempted under the Law. In general, the Act seems to provide for the poorly paid industrial workers, usually the first to be laid off in large numbers during a depression period. The plan provides for a credit system at the rate of four weeks of work to obtain one week's aid in the event of unemployment. Moreover, no employer is obliged to pay benefits until his fund is one year old, and then only to a worker who has resided two years within the State. The benefit is at the rate of 50 per cent of the weekly wage, but is not to exceed $10 a week, and is for not more than ten weeks. Thereafter there is no further liability on the part of the employer unless the fund has been increased from contributions from the employees. Employers have until July, 1933, to set up reserves voluntarily as outlined by the Law. But if at the end of that time "employers

then employing in the aggregate at least 175,000 employees" have not accepted the voluntary system, the Law becomes compulsory for those who have not established systems. The contributions, it should be added, are kept in a trust fund established by The Industrial Commission of the State.

A few weeks ago the Interstate Commission on Unemployment Insurance, consisting of commissioners appointed by the Governors of New York, Massachusetts, New Jersey, Pennsylvania, Ohio, Connecticut and Rhode Island, also submitted recommendations. The program suggested provides for a contribution of 2 per cent of payroll by the employer only. After the reserve per employee exceeds $50 the contribution is reduced to 1 per cent, and remains at this figure until the reserve reaches $75. Thereafter the employer makes no further contributions until the reserve per employee again drops below $75. Payments by each employer constitute the reserve of his own firm and are not to be merged into the common pool. In placing the contributions solely upon the employer it is interesting to note that the Commission reports: "In view of the moderate terms of our proposal, the greatest share of the burden of unemployment would still be borne by the workers whose benefits under the plan would be considerably less than the wages he would have continued to receive if employed. The employed should not, in our judgment, be required to reduce his earnings further by the payment of contributions into unemployment reserves."

Government vs. Private Insurance

A summary of the foregoing plans indicates the nature of the problems encountered in setting up a practical plan of Unemployment Insurance. Abroad most of the plans are governmental, whereas in the United States the solution has thus far been attempted under the auspices of private initiative. Should we continue in the direction we have started? is an all important question. In my opinion a governmental scheme of Unemployment Insurance should be avoided in a democracy for four main reasons, namely:

1. *The Impossibility of Confining the Plan to Those Who Are Normally Employable and Therefore Proper Subjects for Insurance.*—A government plan is bound to become sooner or later the football of politics. It is a superb vote catcher in times like the present. Due to political pressure there is an inevitable tendency to enlarge the classification of unemployment until it includes many who are not properly insurable.

2. *The Tendency Under Government Plans Not To Limit the Employer's Financial Responsibility.*—According to the report of the Interstate Commission on Unemployment Insurance: "Failure to limit liability of the reserve fund is the first and most radical departure from accepted Insurance principles and constitutes an open invitation to supplement contributed funds with subsides from the government or other sources. The adoption of such practices has been the rock on which foreign Unemployment Insurance funds have split, and they have been responsible for the commingling of insurance and relief funds, which is now so universally deplored by all students of this problem."

3. *The Tendency to Liberalize Benefits Unduly.*—Under the pressure of economic stress, there is an almost irresistible tendency towards a liberalization of the benefits, as regards amount and duration of payments, at the expense of the public treasury. The British system, as we have seen, has proved extremely costly. Its original benefits were modified to extend indefinitely during unemployment, forgetting that such indefinite assistance will soon tend to smother the employee's desire to help himself by search for work, or to prepare himself for some other type of work. The "get me dole" spirit is conducive to relaxation and is inconsistent with such desirable attributes of a worker as thrift, independence of spirit, and a desire to secure work by search and preparation. If we fear 2,000,000 railroad workers under public ownership and operation of the railroads, let us visualize the problem of many more millions under a government unemployment system, drawing benefits and at the same time possessing tre-

mendous power in elections, which may turn selfishly towards heavy drains upon the public treasury.

4. *The Danger of Injustice to One Portion of the Community in Making It Contribute, Without Benefit to Itself, to the Maintenance of the Other Portion.*—Thus under the British system some 13,300,000 workers are receiving protection, although probably an equal number of workers are taxed in the interest of the fund without deriving any benefits. In fairness to all it seems that each industry should handle its own problem, either collectively, if desired, or through the operation of plans conducted by the individual firms. A contributory system on the part of both employer and employee will place the burden of contributions upon the parties who benefit. It is difficult to see why farmers, teachers, professional men, shopkeepers, etc. should be asked to contribute their share of the hundreds of millions of dollars of taxes paid in Great Britain for industrial workers.

The aforementioned problems can be avoided through plans operated under the private auspices of industry itself. Joint plans, like the Rochester Plan, and individual company plans, such as that of the General Electric Company, give the advantages of sound business management and freedom from political influence. They are in position, through proper selection, to limit the insurance idea to those who consitute permanent and industrious workers, *i.e.* to those who are normally employable. They are in position to bring about a distribution of risk with the incidence falling fairly upon those who are to benefit. Although still necessarily in the experimental stage, such plans give promise of development through experience and are capable of flexibility in the proper direction. These plans would be in better position than a governmentally operated plan to apply preventive measures, fair and necessary from the standpoint of practicability but somewhat distasteful to large groups of workers. They could also handle the difficult problem of claim adjustments on a more efficient and equitable basis, since they would be acquainted directly with the circumstances surrounding each case of unemploy-

ment. The employer being a large contributor, every effort would naturally be made to eliminate unnecessary unemployment. Moreover, different industries differ greatly in the circumstances surrounding the unemployment problem. Instead of lumping them all together, it would seem better to have each industry adapt its plan to the particular conditions prevailing in that industry. Of course I do not mean to say that the State should not assist private initiative educationally and by way of guidance in preventing and terminating unemployment, in supervising plans which might otherwise fail, just as is done in other forms of Insurance, and in prohibiting plans which are based on unsound principles. Moreover, certain employers may be hardboiled and immovable. Hence the State may even require the establishment of private voluntary unemployment funds, measuring up to certain standards, before the expiration of a designated time limit, subject to a compulsory requirement thereafter. By giving such an incentive to action the State can render a very beneficial service. The fact of the protection may be required, but the actual operation should be left to private initiative uninfluenced by the pressure inherently associated with politics.

Contributory vs. Non-contributory Plans

Another question of prime importance is: Should employees contribute to their unemployment protection or not? Those opposing contributions from the employed usually offer the following three reasons:

1. Wage earners are not responsible for unemployment in industry and are helpless to prevent or terminate such a condition. But it seems to me that it can be argued equally well that employers or tax payers are not to blame, as individuals or individual concerns, for our recurring business depressions or other important business changes, and can serve only towards a partial prevention or termination of the resulting unemployment.

2. The labor force constitutes one of the investments of

industry, just as plant and equipment, and in the event of unemployment the maintenance of this investment falls properly within the industry's overhead charges. Stated in another way, the employed labor force is regarded as an asset upon which the industry must rely for a normal resumption of activities. But may it not be argued with equal force that plant and equipment are also an investment for the labor force? Is business not to be regarded to-day as a partnership of property values and life values, each benefiting from the other? Does not such a view greatly enhance the dignity of labor's position?

3. Workers are necessary to the normal production of industry, and having devoted their lives to the cause of a given industry, possess a legitimate claim upon industry for a living wage? This seems to be the view which has recently been taken by the Interstate Commission on Unemployment Insurance. But may it not again be argued with equal force that owners of capital in industry are also entitled to a decent return and that consideration should be shown to them in the event of business convulsions or other drastic business changes of an adverse nature? Business is speculative in much the same sense that employment is speculative, *i.e.* both partners in the enterprise are affected by the same adverse conditions. Any number of concerns are now operating in the red and dividends are being cut or omitted at an appalling rate. During the single year of 1930, 9 6/10 per cent of all firms listed with Bradstreet and Dunn went into actual insolvency, and during the next year, 1931, the percentage rose to approximately 10 4/10 per cent.

Where the unemployment insurance plan is of a substantial nature, *i.e.*, with benefits of a really worthwhile character to meet depression conditions, it seems clear that we cannot look to the employer alone, in view of the huge risk involved. Non-contributory plans must inevitably result in very meagre promises to the unemployed. They can at best promise only a few weeks of benefits, at half pay, in any given year, and that falls far short of the problem resulting from general business convulsions.

Existing plans, while a distinct improvement over previous conditions, make the afforded relief pitifully small. As in the case of old age protection Unemployment Insurance of a substantial nature requires, in my opinion, that a substantial part of the benefit realized by the insured be contributed by the recipient. I would suggest a half and half arrangement between employer and employed. Only in that way may we avoid the prevailing charity plans of to-day, and meet in a larger sense the avalanche of unemployment occurring every seven or eight years. This arrangement seems fair and it is also dignified. Substantial assistance through Insurance can be expected only if the recipient is willing to supplement the employer's contributions with a generous saving of his own. I would suggest utilization of the fat years of the industrial cycle to accumulate unemployment funds at the rate of at least 5 to 6 per cent of the payroll (instead of the customary 2 per cent prevailing in present plans), contributed half and half by employer and employed. A Contribution of 2½ or 3 per cent of payroll by the insured worker during prosperous years should not occasion any material suffering. In the overwhelming mass of cases, it will mean only a little compulsory thrift, and the lopping off of various frills not at all essential. And if there be a little suffering during the prosperous years, let us not forget that, if it is borne for the six or seven fat years, there will be a great alleviation of the much greater suffering during the lean period. To avoid excessive sacrifice in the depression period, it is necessary to sacrifice regularly on a smaller scale during the longer period of prosperity.

Preventive Measures

Under this heading I do not have in mind only prevention of unemployment itself, important though that be, but also the alleviation of the acute financial suffering of jobless people during long and unavoidable periods of unemployment. The latter phase of the prevention program has received but scant attention, yet it is deserving of the utmost consideration in

the formulation of any unemployment insurance plan. Present experiments in this country are so pittifully modest in their promised benefits, rarely extending beyond the giving of half pay during ten weeks in any year. Yet the most important objective it would seem, if charitable relief is to be reduced to a minimum for insurable employees, is to afford at least half pay for a much longer period of unemployment for those whose income is such as to make self-thrift-help difficult. I would therefore suggest emphasis upon the following, in the interest of an elongated period of benefits:

1. Make the amount of benefit equal to one half of the recipient's annual wage, should he be entirely laid off from work, and only sufficient to make up 50 per cent of normal pay if he be working on part time; moreover exclude from the plan all whose income is more than $1,750 a year. Those with incomes of that amount or over are in position, if they so will, to save a reasonable amount or to utilize legal reserve life insurance, which, as already explained, is Unemployment Insurance in that its accumulating cash value constitutes an emergency fund always available when an emergency arises.

2. Increase the contributions to the fund from the customary 2 per cent to 5 or 6 per cent of the payroll, and have them contributed half and half by employer and employed. This will yield 2½ to 3 times as much and presumably will extend the period of benefits an equal number of times beyond present limits. In view of the frequency and seriousness of the hazard it is not unreasonable, as has already been explained, to expect employees to contribute this amount regularly for their own unemployment protection.

3. Increase the waiting period from the customary one or two weeks to four or five weeks. It is preposterous to feel that workers, normally employable and therefore insurable, should be down and out financially almost immediately after the blow of unemployment strikes. Such a viewpoint assumes almost complete absence of thrift. It is difficult to imagine that any employee, worthy of help, who has this matter explained to him, should be so improvident as to

neglect to make provision for at least four or five weeks maintenance. During normal years the great mass of unemployment experiences extend over short periods only. The lengthening of the waiting period as suggested would save a lot of money to the fund by eliminating all out-of-employment periods of less than four or five weeks. This saving would be available for lengthening the period of payments during an industrial crisis.

The unemployment fund could be preserved still further, in the interest of elongating the period of benefits, by utilizing ways and means of preventing unemployment itself. In fact such prevention may prove a much greater factor than compensation itself. This has been the story in many other lines of Insurance, and it is only too true, as the greatest disciple of thrift and Insurance, Benjamin Franklin, once said: "An ounce of prevention is worth a pound of cure." Prevention of loss in the first instance is the greatest Insurance of all. It is certainly best to reduce unemployment to the irreducible minimum and then compensate that which apparently cannot be prevented.

Time will permit only the mentioning of some of the ways and means of prevention. All of them have great possibilities if properly studied and applied. Where the nature of the work makes it possible, the work may be distributed so as to keep nearly all employees on the payroll for shorter working periods, rather than to lay off some entirely and keep the rest on full time, so that the great majority of workers in a given industry may still earn 50 per cent of their customary income and not be a tax upon the unemployment fund. Various industries may cooperate in giving preference in their businesses to those who become idle in others, a plan of real value where the nature of the work in some of the cooperating firms is such as to have active times when others experience dull times. Much could be accomplished through a pre-arranged plan of public works, an ideal way of supplying work during slack times. But for the present nothing can be done and this method will remain hopeless until legislators can be educated

to the desirability of making regular annual appropriations during the fat years for deferred use during the lean years. Again, attention may be directed to the maintenance of efficient public employment offices, which will study the problem for their respective localities, and be ready to redistribute laid off workers to other places of work. Avoidance of undue expansion in industry during flourishing times, the use of over-time in departments extremely busy at certain periods rather than the engagement of new labor, and the stocking of goods for the future are other methods through which much can be done to stabilize labor.

If such preventive efforts are coupled with an unemployment reserve, based on the aforementioned principles, we may hope to arrive at something akin to that which has been set up by well managed corporations for the stabilization of incomes to dividend receivers. Owing to the stupendous nature of the problem, Unemployment Insurance plans may never be sufficiently perfect to meet the actuary's concept of the requisites of mathematically scientific Insurance, amounting to contractual dependability. But we cannot wait for the actuary, who wants detailed data and known experience before starting. Rather we must accept the English view of risk-taking based upon judgment—so frequently applied in many of the newer forms of Insurance coverage—instead of the more or less prevailing American idea of Insurance based upon data so complete as to make the proposition a substantially no-risk one from the standpoint of the underwriter. As I see it, we must act soon and make a constructive beginning. The beginnings must be in the nature of self-insurance plans; later the experience may enable the risk to be assumed contractally by private underwriters. Employees and dividend receivers are partners. Both are interested vitally in regularity of income. Their problem is a similar one, for private initiative to tackle and master substantially, although probably never perfectly. Both must sacrifice regularly during the prosperous years to avoid greater sacrifice during depression years. Although not perfected to meet every unforeseen

avalanche of unemployment, just as Fire Insurance systems in the past have failed to meet every unforeseen conflagration, yet any substantial accumulation for unemployment purposes will prove serviceable, in a dignified non-charitable way, to the extent that the fund has been accumulated.

SYMPOSIUM—THE PRESENT ECONOMIC SITUATION

PRESENTED APRIL 23, 1932

PAST CRISES IN RETROSPECT AND IN CONTEMPORARY OPINION

By VICTOR S. CLARK

IN THE brief time allotted me to review the principal American depressions of the nineteenth century, it is impossible to describe them individually. Even my allusions will necessarily be confined to the five outstanding periods of distress popularly associated with the years 1819, 1837, 1857, 1873, and 1893. Other eras of crisis and collapse are recorded in our business history, but none of them was so protracted, or so general, as the five just mentioned.

All these cycles exhibited the familiar phases of inflation, panic, depression, and recovery. Each lasted for several years. Each was considered by its contemporaries the severest on record. All of them coincided approximately with similar events in other countries.

Our earlier panics were commonly ascribed to an excessive expansion and contraction of the currency. In 1819 and 1837 state banks flooded the country with notes based upon inadequate security, which they forced into circulation by over liberal, and at times dishonest, credit policies. Superabundant money and credit raised prices far above the level of true values, encouraged speculation, and ended in a suspension of specie payments and acute deflation. Between 1815 and 1819 the amount of money in circulation fell from $110,000,000 to $45,000,000, a contraction of fifty-nine per cent in three years. Between 1837 and 1842 the decline was from $139,000,000 to $83,000,000, a shrinkage of nearly forty

per cent. Instead of worrying over a hypothetical departure from the gold standard, people in our earlier panics faced the actuality of suspension of specie payments, and of doing business with inconvertible, ill secured, fluctuating, and often counterfeited bank notes, that had an uncanny way of vanishing when most needed. In 1857, 1873, and 1893 we still had monetary difficulties, when specie payments were suspended and currency premiums were exacted. Following the crises of 1873 and 1893 clearing house certificates took the place of currency in transactions between banks, and unorthodox substitutes for money circulated in private trade. But the machinery of credit was by this time more complex, and the commercial and investment policies of banks had grown more important than their note issuing functions. Consequently the curtailment of accommodations to customers was one of the most keenly felt features of the second phase of these later cycles. In 1857 the principal New York banks contracted their credits to customers by over seventeen per cent within five weeks. During seven weeks of the severest stress in 1873 the shrinkage was about ten per cent; and during the five worst banking months of 1893, loans shrank nearly fifteen per cent.

Contraction of the currency and of bank credits, therefore, characterized the panic phase of all these cycles, but it was somewhat less severe as the monetary system and the banking structure of the country matured.

Let us now turn to the investment features of these eras of business dislocation. "Frozen assets" is a new name for an old thing. The term is not synonymous with bad assets, though when prices are the sport of irrational psychological moods the two may become for the moment almost coterminous. An unsound growth of nominal assets is the product of every conjuncture when legitimate trade degenerates into gambling. One of the most marked differences between such eras in new countries like America and in older countries like Great Britain, is the greater attention given in the former to land as an object of speculation. Real estate booms were a

feature of the inflationary phase of all of the cycles I have mentioned. After the crisis of 1819, real estate values for both urban and farm property along the eastern seaboard declined from sixty to seventy-five per cent. After 1837, the shrinkage may have been even greater, especially in the west and the southwest. Indeed, in 1857, twenty years after this crisis, millions of acres of land had not yet reached the value at which they sold and resold at that time. The real estate of New York City was assessed for more in 1836 than it was in 1851, though the latter year was one of great activity. Competent witnesses, appearing before a Congressional committee in 1878, testified that the shrinkage of real estate values in Chicago during the depression then drawing to a close was from fifty to sixty per cent. In a paper read before the Philadelphia Social Science Association the same year Mr. Robert J. Wright also comments upon this aspect of the 1873 depression:

> The census of 1870 shows, that, taking the whole country, the increase in nominal value of real estate in ten years was about 190 per cent, whilst that of personals was almost nothing. This shows enormous increase in the nominal value of realties, without a corresponding increase of necessary chattels. The statistics show also, that in the agricultural portions, the personals must have *decreased*, because they largely *increased* in the towns, whilst the total for the whole country was stationary." [PHILADELPHIA SOCIAL SCIENCE ASSOCIATION. *Cause and Cure of Hard Times.* Philadelphia 1878.]

The depression of 1893, again, was preceded by land booms in the south and west. It is hardly necessary to mention Florida five years ago. In this connection, farmers have always been among the heaviest sufferers from a business crisis. Drought and crop failures aggravated depressions, especially in the thirties and the early nineties. Low prices for farm produce did even more to impair rural land values. Grave concern was felt by American farmers during the industrial stagnation of the seventies and middle eighties lest new competition from India and Egypt, following the opening

of the Suez Canal might permanently lessen the foreign demand for our wheat and cotton.

Prior to the Civil War our merchant marine held a more prominent place in the national economy than it does today. Huge profits realized from the carrying trade during the Napoleonic Wars invited large investments in American shipping. The sudden collapse of this trade after the Treaty of Ghent brought ruin to many of our merchants, and wiped out at a stroke from twenty to twenty-five million dollars worth of property, which was equal to about one fourth the entire banking capital of the country. At a later date American shipping shared the prosperity begotten by new traffic created by the gold discoveries in California and Australia, by the development of the guano business with South America, and by a demand for tonnage accompanying the Crimean War. That boom was followed by a slump, aggravated and continued by a shifting from wooden to iron vessels, and from sail to steam tonnage, which impaired and dislocated investments along our eastern seaboard. But far more important than this was the fixation of capital in railroads. As early as 1837, the diversion of liquid funds to fixed investments in the cotton and woollen mills of New England, in the railways that were just beginning to creep inland from our Atlantic ports, and in canals, was a recognized cause of the prevailing financial stringency. The crises of 1857 and 1873 were in no slight degree railway panics. Not until the 1893 cycle did great industrial combinations, like the Cordage Trust and its contemporaries, rival railways as an immobilizing factor in our capital structure. Between 1893 and 1895 listed dividends to an annual total of nearly $62,000,000 were passed, and to quote a contemporary financial writer, "The bad investments of the public within three years came fully up to $1,500,000.000."

This freezing of assets during inflation in transportation agencies, industrial plants, and other producers' goods far beyond the immediate needs of the country, unfortunately coincided with rapidly increasing imports of consumers'

goods, especially luxuries. The additional burden which the competition of this merchandise in the domestic market threw upon home producers, and the drain it represented upon the liquid assets of the country, were felt most keenly during our earlier crises, when such merchandise formed a larger share than it does at present of our national consumption. Unprecedentedly heavy importations after the second peace with England and during the prosperity of the middle thirties and the middle fifties, were particularly prominent in the public eye as a cause of the subsequent monetary stringency. Those were the days of homilies against extravagance, of which pages could be quoted from the press and periodicals of the time.

Losses sustained by unwise investment in America were shared between our own people and their foreign creditors. British merchants, manufacturers, financiers, and investors made a profit, upon the average, from their business with the United States. During the periods we have particularly in mind, however, these profits were heavily discounted, and occasionally turned into losses. No small part of our early banking capital was British. Our importing merchants did business on English credit. Our states and municipalities, our railways and factories, sold their stocks and bonds—and at times defaulted their interest—to British and continental investors. These credit relationships extended beyond direct financial connections between New York and London. When, during the twenties and thirties and again during the eighties of the last century, British bankers and investors placed their funds in South America quite as imprudently as our bankers and investors have done since the World War, and consequently were forced to take heavy losses, they curtailed their credits to our own people, thereby hastening and aggravating an inevitable deflation. Today's recriminations against American investment bankers and preachments on the folly of guileless American investors in foreign securities, repeat almost verbatim tirades upon this subject in Great Britain during earlier periods of financial disaster, when the

United States, South America, Australia, and other borrowing countries played the same rôle of shifty insolvence in the British public mind that the less fortunate countries of the world play in the public mind of America at the moment.

Comparing the five cycles I have mentioned with each other, and with the successive phases of the cycle we are passing through today, we are moved to infer that the acuteness of such disturbances diminishes somewhat with the progress of society. Philadelphia has felt our present depression severely, but it is doubtful if conditions here, or in any other American city, have been as unhappy as they were in 1819 and the years following. Between 1816 and 1819 a canvass showed that the number of employees in thirty leading branches of manufacture in Philadelphia, of which the principal were the cotton and woolen industries, decreased from nearly 9700 to some 2100, or more than seventy-five per cent. In Pittsburg workers on the payrolls of the principal industrial establishments, chiefly foundries, steam engine factories, and nail factories, decreased almost two thirds during the depression, or from nearly 2000 to less than 700. House rents in Philadelphia and New York City fell fifty or sixty per cent. Many residential sections of Philadelphia were then formed, as they are today, of houses belonging to mechanics and small tradesmen, built with their savings upon leasehold land. These people, like the wealthier classes, found the value of their improvements reduced virtually to zero because ground rents alone exceeded the income value of the improved property. To quote a writer of the period:

"Hundreds of old people, of widows, of fatherless children, who were wholly dependent upon this species of property, were reduced to utter ruin and beggary; and that city, which I knew with sixty thousand souls in it, without a single beggar, or a single person whom you could properly call a pauper, became a scene of beggary and of pauperism; . . . and quite horrible to relate, *crime*, which was scarcely heard of, at the time when I lived there, had so increased, that there were three or four thousand commitments annually in

Philadelphia alone . . . ." [THE CURSE OF PAPER-MONEY AND BANKING. By Wm. M. Gouge. Philadelphia 1833.]

After 1837 conditions in New York were equally distressing:

"The winter of 1838 was unusually severe. The times were hard, fuel and food were dear, many thousands of men and women were out of employment, and there was general distress. As the cold months wore slowly on, the sufferings of the poor became so aggravated, and the number of the unemployed increased to such a degree, that the ordinary means were inadequate to relieve even those who were destitute of every one of the necessaries of life. Some died of starvation. Some were frozen to death. Many, through exposure and privation, contracted fatal diseases. A large number who had never before known want, were reduced to beg. Respectable mechanics were known to offer their services as waiters in eating houses for their food only." ['37 and '57. By members of the New-York Press. New York 1857. Chapter V, pp. 29–30.]

A different aspect of these unfortunate periods was stressed by a New York banker in reviewing the events of 1857 and 1858:

"A prodigious weight of insolvency had been carried along for years in the volume of trade. Extravagance of living had already sapped the foundations of commercial success, in hundreds of instances where credit supplied the place of lost capital. Mismanagement and fraud had gained footing in public companies to an incredible degree. Hundreds of millions of bonds were issued with little regard to the validity of their basis, and pressed upon the market by dishonest agents, at any price, from sixty down to thirty cents on the dollar. False quotations were obtained by sham auction sales. The Press, in particular instances, was bribed into silence, or became a partner in the profits to be derived from the various schemes which it commended to general confidence. The land grants by Congress to railway companies gave renewed activity to speculation, and State Legislatures were bribed to locate roads to serve individual interests. Public, as well as private credit, was compromised. The example of corruption in Government commissions and contracts and of bad faith with neighboring nations, was an extreme, but a faithful expression of the tone of popular feeling with respect to the sacredness of trusts and obligations." [THE BANKS OF NEW-YORK. By J. S. Gibbons. 1859. p. 374.]

In this depression also unemployment and distress promoted crime. In 1858 a New York editor wrote:

"Revolvers are carried openly, and freely used. Thieves, rioters, gamblers and pickpockets frequent our public assemblies, and turn our places of amusement into arenas of riot, debauchery and plunder. It is becoming unsafe to leave one's dwelling in the night, and murders of the most shocking description, and of every day occurrence, escape even the appearance of punishment. Our prisons are no longer able to contain their inmates, and nothing short of a Vigilance Committee seems to promise any relief. . . . Our laws are no more than cobwebs, if a criminal or his friends have money, and our police are not only inefficient, but are suspected of being in league with the villains who prey upon society." [THE DAY AND ITS DEGENERACY. *New York Herald*, Tuesday, May 18, 1858. p. 4.]

The crises of 1873 and 1893 were accompanied by serious labor disturbances. Some of you are doubtless familiar with the story of the Molly Maguires, and of the Pullman strike.

These sketchy comments upon a theme altogether too broad and deep to be handled in a brief paper touch only a few high points in the history of our chief nineteenth century cycles. They do not attempt to analyze their causes, to record their course, or to deduce their lessons. It is almost a century since Americans were saying, "This crisis must be our last. We must find some scientific remedy for such disasters. Society cannot withstand an indefinite number of such social shocks." But we remain pretty much where we were in 1837, or in 1857, so far as effective economic forecasting and control are concerned. In 1867 a student of economic phenomena presented a well-reasoned paper upon Britain's recent difficulties before the Statistical Society of Manchester, England, in which he said:

"We find that the malady of commercial crisis is not, in essence, a matter of the *purse* but of the *mind*. And regret it as we may, it seems as if, for the present, these rapid mercantile mutations were as inevitable as the periodical tempests which clear the atmosphere of tropical regions. . . . Commercial Credit runs through the mutations of life, having its infancy, growth to a

maturity, diseased over-growth, and death by collapse; and . . . each cycle is composed of well-marked normal stages, corresponding to these ideas in nature and succession." [ON CREDIT CYCLES, AND THE ORIGIN OF COMMERCIAL CRISES. By John Mills. Manchester Statistical Society Transactions, Sess. 1867–68. pp. 16–17.]

Is not this explanation of the ultimate origin of crises as fundamental as any that can be offered? Except in their quantitative aspects, our cycles today are not essentially different from those of two or three hundred years ago,—for example, in the time of John Law's scheme in France, and the South Sea Bubble in Great Britain, when the general public became speculation mad, and inflated shares crashed within a few days to one tenth or less of their former value. A classical example of an early crisis is the tulip mania in the Netherlands, so familiar to economic historians. That country was enjoying a period of unusual prosperity. Capital accumulated, and money was diffused among classes ignorant of the principles of sound investment. To quote from a contemporary pamphlet, "noblemen, merchants, mechanics, ship masters, peasants, turf diggers, chimney sweeps, house boys, house maids, and huckster women" began to speculate. The objects upon which they pitted their bets for gain were so absurd from a sane economic standpoint that the story reads like a madhouse tale. To quote from an eminent Dutch historian:

"The impulse to risk much in order to gain much, the pernicious spirit of speculation, claimed many victims in these times. After long dealing with the commerce in grain, oil and whalebone, Indian spices, and other articles subject to great fluctuations in price, speculation in Holland found in the autumn of 1636 a new field in the tulip trade. It took advantage of the fashion of raising bulbs and blossoms for the gardens of town and country, where in some regions almost no more fruit trees and shrubs were to be seen, everything having been rooted up so that coloured flowers, tulips especially, could be grown. The meetings of the florists, where they came together in the cities of Holland to dispose of their bulbs, were soon centres of the rage for speculation, at first among the florists themselves, then among other citizens. These 'chambers' were besieged by rich and poor, hoping rapidly to

become wealthy from the colossal prices attained by the bulbs, sold for delivery in the following summer but hardly yet standing in the field. Hundreds, thousands of guilders were paid for some growing bulbs, plants of the future. In a single city transactions amounted to over ten millions. Large sums of money were made upon paper, and, when there suddenly came a decline early in February, 1637, were lost by people of all ranks, men and women, magistrates and citizens, peasants and tradesmen, seamen and carters, who had deserted their work to get rich quickly by the traffic bulbs. At Leyden, Haarlem, Alkmaar, Hoorn, Enkhuizen, and Amsterdam much was won and lost, and finally many a household was broken up, and many a life was ruined, more than figures can tell us. On the sudden fall an effort was made to save matters by providing that upon delivery only 10 per cent. of all prices agreed upon after November should actually be paid. But this afforded no relief, since many had bought for large amounts and were without sufficient means. All had counted upon great profits, and many men of property saw themselves robbed of everything—a 'brainless business' that reduced thousands to beggary. The Estates of Holland and various town-councils did all possible by the suspension of payments to avert the severest injury, but they could not prevent countless financial failures, as sale and purchase had taken place in the customary form and with written engagements. Thus ended miserably in April, 1637, the tulipomania amid the curses of hundreds who were bitterly disappointed or had anticipated their great expectations of wealth after the manner of the milkmaid in La Fontaine's fable." [HISTORY OF THE PEOPLE OF THE NETHERLANDS. By Petrus Johannes Blok. Part IV. Translated by Oscar A. Bierstadt. New York and London 1907. pp. 91–93.]

Fundamentally was this craze materially different from the stock market craze of 1929 in America? As long as so many of us are Smileys, eager to bet on straddlebugs and jumping frogs whenever a sufficient reservoir of resources has accumulated to start inflation, what assurance is there that the legitimate channels of business will not be overrun and mobbed at regular intervals by amateur clamorers for unearned gain? Well toward a century ago, during a time of national penance like the present, Henry Ward Beecher wrote:

"He who buys stock as a *bona fide* method of investing his funds, looking for dividends, or for some benefit from the interest repre-

sented by the stock, buys legitimately and without moral blame. But that whole scheme of buying stocks for no other purpose than to make money upon the bet that they will rise or that they will fall, is a scheme of gambling. In this gambling game the whole community have more or less participated."

Nor is this form of gambling the only channel through which men hazard their fortunes in times of inflation. A German student of cycles has aptly written:

"The number of inventive minds, who discover new devices and break new paths is small. The number of imitative minds, who live by copying, and rush into new and promising lines of production is countless. In times of expansion their competition becomes epidemic, and increases the disequilibrium between the offer and demand of goods." [GESCHICHTE DER HANDELSKRISEN. By Max Wirth. Frankfurt 1883.]

Economists can analyze cycles, though they seldom successfully forecast them. But ultimate causes and remedies may lie without their province. Possibly these are problems for the sociologist,—or shall we say for the social psychiatrist?

GOLD AND THE GOLD STANDARD

By EDWIN WALTER KEMMERER

In the judgment of many people, the financial crisis beginning in the fall of 1929 and the subsequent crisis and world economic depression are primarily a monetary phenomenon, attributable chiefly to the defects of the gold standard. Like the long period of falling prices culminating in the middle nineties of the last century, the recent price decline is charged by many to an alleged world shortage of gold.

Today I wish to examine some of the significant facts in the relationship of the gold standard to the present world economic crisis.

For a period of nearly a quarter of a century, ending in 1896, there was a pronounced and almost continuous decline in price levels in all gold-standard countries of the world—a decline that was due chiefly to a world scarcity of gold—in other words, to a failure of the world's gold production to increase sufficiently to enable the world's monetary gold supply to meet the increasing demands placed upon it. However, largely as a result of the great increase in gold production beginning in the early nineties, coming chiefly from South Africa, price levels in gold-standard countries began to rise about 2.4 per cent annually (compounded), the wholesale commodity price level in the United States in 1913 was about 50 per cent higher than in 1896, likewise the wholesale price levels of Canada and Germany; while those of Great Britain and France were about 40 per cent higher, and there were similar advances in all other gold-standard countries. Then, in 1914, the world was struck by the Great War, the gold standard was everywhere given up, and the prices of commodities, expressed in terms of gold, soared to unprecedented heights.

In the United States, wholesale prices rose 121 per cent from 1913 to 1920.

This extraordinary advance was due chiefly to two causes, which supplemented each other, one being of a permanent and constructive character and the other being of the nature of a serious, temporary evil, though possibly a necessary evil, which was one of the costs of the War. The first cause was the inflation incident to the establishment of the Federal Reserve System, and the second was the World War inflation itself.

Federal Reserve System Increases Efficiency of Gold

Prior to 1914, our currency and banking system was cumbersome and inefficient. Its reorganization under the Federal Reserve Law made it much more efficient and, therefore, enabled a given amount of gold reserve to do a greatly increased amount of money and credit work. Federal Reserve notes with a legal gold reserve of 40 per cent were substituted extensively in circulation for gold certificates with a required 100 per cent reserve; and, more importantly, the actual amount of money required by law to be held somewhere as legal reserves against a given amount of member bank deposits was reduced by the Federal Reserve Law by 1917 to something like one fifth what it was in 1913. For several reasons, notably the accompanying expansion of Federal Reserve note circulation and the discontinuance of member banks' privilege of counting till money as part of their legal reserves, not all of this legal slack could actually be taken up, but a great part of it soon was. Bank note and bank deposit expansion were made possible on a large scale and the efficiency of our banking machinery in general was greatly increased.

War-Time Economies in the Use of Gold

During the period of the Great War and the two years immediately following the Armistice, most of the world gave up the gold standard and went over to paper money. Gold coin was everywhere withdrawn from circulation and the

world's monetary gold was largely piled up in the vaults of a few central banks, where it was not used. Enormous quantities of this gold, coming to the United States from Europe in the purchase of war supplies and in the transfer of capital fleeing here for safety, accumulated in our Federal Reserve banks. From August 1913 to August 1919, our stock of monetary gold in the United States increased by 65 per cent. In time of war, when nations are fighting for their national existence, they need food, clothing, armament and munitions much more than gold. During the period of the World War, a gold standard was a luxury that the belligerent countries of Europe could not afford. The demand for gold declined enormously, gold depreciated, and by 1920 the American dollar had lost about 55 per cent of its pre-war value.

Post-War Deflation

With the close of the War, however, the world was determined to return to the gold standard as soon as possible after its long and painful experiences with managed paper currency. This would obviously mean a large increase in the demand for gold, and, in consequence, a great increase in the value of gold in terms of goods—in other words, a great fall in prices. There would be nothing like enough gold to go around if the world were to return to the gold standard at the high American price level of 1920. In late 1920 and early 1921 the expected price collapse came, and in one year our American wholesale commodity price level dropped about 44 per cent, representing an increase of approximately 57 per cent in the value of gold.

Stable Commodity Prices and Rapidly Rising Security Prices

After the war-time gold inflation, culminating in 1920, followed by this inevitable post-war deflation of late 1920 and early 1921, the value of gold settled down to a long period of unusual stability between the spring of 1921 and the autumn of 1929. During the nine years 1921 to 1929, the extreme

variations in the average annual figures for the value of gold in the United States as measured by its purchasing power over commodities at wholesale were only 8½ per cent, and from March 1921 to the end of 1929 the extreme range of variation in the monthly figures was only 14 per cent. For the same nine years the range of variation in the purchasing power of gold as measured by the New York Federal Reserve Bank's Index Numbers of Average Annual General Prices was less than 10 per cent.

During this period, however, of a comparatively stable commodity price level, the United States witnessed one of the wildest speculative booms in stocks and real estate the country ever saw. The experience is too recent to require discussion. Sufficient to note that the index number of the prices of 404 stocks, compiled by the Standard Statistics Company, increased 308 per cent between 1921 and September 1929, and that the number of stock shares sold on the New York Stock Exchange rose from 171 millions in 1921 to 1125 millions in 1929, representing an increase in eight years of 558 per cent.

Crisis and Depression of 1929–1932

Then came the collapse. Prices of stocks and of real estate fell in the brief space of a little over two years from heights that now seem to all of us to have been fantastic to depths that in a few years will probably appear to be equally fantastic. Although commodity prices did not advance with the prices of stocks during the boom, when the break came they were dragged down along with the tobogganing security prices.

Between the highs of 1929 and the lows of March 1932, the Dow-Jones average for 30 active industrial stocks declined 81 per cent, that for 20 leading railroads declined 84 per cent, and the *New York Times* average of 40 bonds declined 29 per cent. From the high of 1929 in July to March of this year, the level of wholesale commodity prices in the United States fell by 32 per cent and we are now 5 per cent below the level of 1913. The purchasing

power of gold over commodities at wholesale in the United States was 48 per cent higher in March of this year than it was just three years before; and in March 1932 it was 31 per cent higher than it was three years before, over goods and services of all kinds, as measured by the General Index Number of the New York Federal Reserve Bank.

Is this great decline in the wholesale price level, or, in other words, this great rise in the purchasing power of gold over commodities, to be explained, as claimed by many, on the ground of a permanent shortage in the world's stock of monetary gold, or on the ground of a maldistribution in this stock due principally to the gold-grasping policies of the United States? Let us look briefly into these two claims.

"Shortage" of Monetary Gold

First, is there any evidence of a permanent shortage in the world's stock of monetary gold?

Here one must carefully distinguish between the question of a long-time shortage, upon which it is alleged we have already entered, and the question of whether the world is merely now facing a shortage in the not distant future. It is only the former question with which we are here concerned.

The principal grounds for claiming that such a shortage exists are three: (1) the great increase in the value of gold since 1929, as evidenced by the decline in commodity prices in gold-standard countries which we have just mentioned; (2) the fact that the world's gold production declined substantially during the years 1917–1922 and that, although there has been a considerable recovery since that time, the world has not yet gotten back to the high production level of the period 1908–1916; (3) the fact that the demand for gold increased greatly, during the eleven years following the Armistice, as a result of the growth of the world's production and trade and of the return of a large part of the world to the gold standard. Let us consider these reasons very briefly.

If the world were suffering from a permanent scarcity of

monetary gold, this scarcity would be likely to be felt in a slow and continuing decline in prices, as it did in the period 1873 to 1896, rather than in a catastrophic drop like the one we have recently had following a long period of comparatively stable prices. The value of gold is a question of the world's total supply of gold in relation to the world's total demand for gold; and the world's total supply of gold is a very large sum, representing the accumulation of the ages, while the world's annual production of gold is a very small percentage of this total supply. The world's supply of monetary gold in the gold reserves of central banks and governments alone is today over eleven billion dollars, while the world's total annual production of gold is less than 4 per cent of this figure, and only a little over half of that normally goes into monetary uses. Slight changes in annual increments, which themselves represent only a little over 2 per cent of a total volume, affect that volume very slowly. In this connection, it should be noted that the comparatively stable commodity price level in the United States from 1921 to 1929 was a high level—averaging 41 per cent above that of 1913.

World's Production of Gold

Although the world's gold production fell off considerably during the War and early post-war period, the world's supply of monetary gold has increased substantially and almost continually since 1913. The world's average annual gold production for the eight years ending 1913 was 21,514,000 ounces; for the eight years ending 1921 it was 19,354,000 ounces; and for the eight years ending 1929 it was 18,660,000 ounces. The average for the last two periods was only 11 per cent less than for the pre-war period—which was the greatest in the world's history—and the average for the years 1930 and 1931—20,815,000 ounces—was only about 3 per cent less than for this period of pre-war maximum. South Africa's gold production in 1931 was the largest in its history.

World's Supply of Monetary Gold

Turning from the world's gold production to the growth of the world's supply of monetary gold, absolutely and relatively to the world's production of basic commodities, we find no evidence of a permanent scarcity of monetary gold. The Federal Reserve Board estimates the world's stock of monetary gold in the hands of central banks and governments at the end of 1921 at $8,023,000,000 and at the end of 1929 at $10,297,000,000. This represents an average annual increase (geometrical) of about 3.2 per cent. For the eighteen years 1913 to 1931, this world stock of monetary gold increased 127 per cent, representing an average annual increase (geometrical) of 4.7 per cent. The studies of Dr. Carl Snyder of the New York Federal Reserve Bank, covering the principal commercial countries of the world for the period 1865 to 1914, show a rate of increase in the physical volume of production of basic commodities—tons, bushels, yards, etc.—of approximately 3.15 per cent a year. For the sixteen-year period from 1913–14 to 1929–30, the annual rate of increase was only 1.86 per cent, and, for the nine years 1920 to 1929, it was 3.2 per cent.

The index numbers for the world's supply of monetary gold are shown on Chart I, those for the period 1896 to 1913 (Graph B) being the figures compiled by the League of Nations and those since 1913 (Graph D) being those of the Federal Reserve Board. Graph C represents the Snyder Index Numbers for the world's production of basic commodities. Graph B on Chart II shows the world's supply of monetary gold relative to the world's production of basic commodities. These figures give no evidence of a scarcity of monetary gold.

Under normal conditions, there would be no need of the world's stock of monetary gold increasing as rapidly as the world's production of basic commodities or physical volume of business, because, with continually improving currency and banking organizations, with increasing coöperation on the part of central banks, with increasing use of checks in business

MONETARY GOLD, PRODUCTION OF BASIC COMMODITIES AND WHOLESALE PRICES

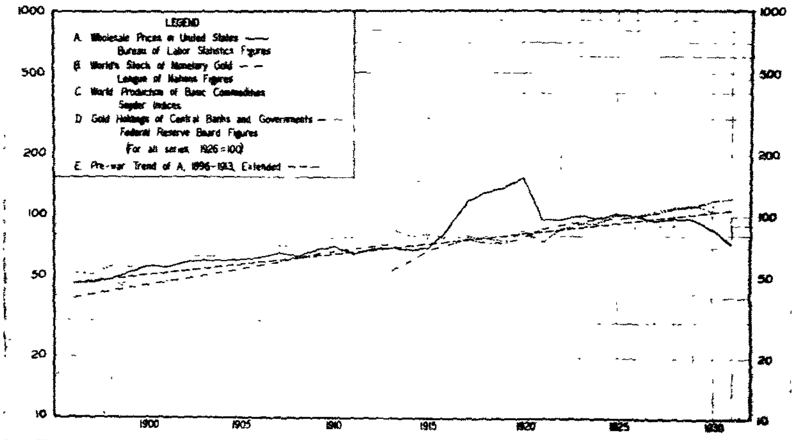


CHART I.

transactions in substitution for coins and notes, and with increasing rates of monetary and deposit turnover, the efficiency of monetary gold should be continually increasing.

U.S. WHOLESALE PRICES AND WORLD SUPPLY OF MONETARY GOLD RELATIVE TO PRODUCTION OF BASIC COMMODITIES

(1926 = 100)

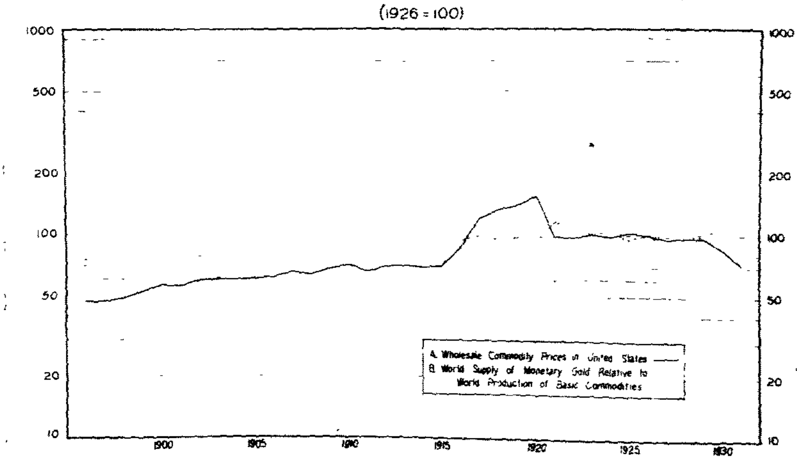


CHART II.

It may be reasonably concluded, therefore, that, for the approximately nine-year period from April 1921 to the end of 1929, during which commodity prices in the United States were fairly stable at a level averaging about 41 per cent above the pre-war level and during which the world's stock of monetary gold increased on an average of 3.2 per cent a year and the world's production of basic commodities likewise increased about 3.2 per cent a year, there is no evidence that the world was suffering from what could be called an enduring scarcity of monetary gold.

The world's stock of monetary gold in February 1932 was approximately 13½ per cent greater than it was three years before and the recent increase in the value of gold is stimulating gold exploration and production.

While it is true that during the decade 1921 to 1930 many countries went over to the gold standard, nearly all of these countries had been on the gold standard before the War, and their return to it did not represent an increased demand for gold as compared with the pre-war demand. Furthermore, a large number of these countries substituted the gold exchange standard and the gold bullion standard for the pre-war gold coin standard, with a resulting almost complete discontinuance of the hand-to-hand circulation of gold coin throughout the world, thereby effecting very substantial economies in the use of gold. Moreover, contrary to all expectations, gold is now being poured on the world's markets from the hoards of India in large quantities, over $100,000,000 having recently come from that source. Since the outbreak of the World War Russia has poured over $600,000,000 of monetary gold into the rest of the world.

"Maldistribution" of Gold

Let us next consider briefly the question of the so-called "maldistribution" of the world's stock of monetary gold.

At the present time the stock of monetary gold held by central banks and by the governments of the leading countries of the world is approximately $11.4 billions. Of this amount

the United States has approximately $4 billions, or about 35 per cent, France has approximately $3 billions, or 26 per cent, and the rest of the world has about $4.4 billions, or 39 per cent of the total.

Is the charge true that we so frequently hear that the United States has forcibly drawn to itself an unreasonable proportion of the world's stock of monetary gold and has deliberately and selfishly impounded it here? The answer, I think, is clearly "No."

In the first place, no one has yet given a satisfactory answer to the question, "What proportion of the world's stock of monetary gold is the United States entitled reasonably to have?" Our stock of monetary gold in 1913 was approximately $1.9 billions, or 22 per cent of the world's total. Our proportion was not then considered excessive. Our percentage of the world's stock has now increased from 22 to 35, but, in these intervening 19 years, the United States has had a great economic development. Dr. Carl Snyder estimates, as previously mentioned, that, since 1865, the rate of physical production of basic commodities in the advanced countries of the world, taken together and including the United States, has increased at a progressive rate of about 3 per cent per annum; while that of the United States by itself has increased at an annual rate of about 4 per cent. We were not so hard hit by the War as were the principal countries of Europe; we recovered more rapidly and our economic advance has been faster in recent years than that of most other countries. Our relative importance in the economic world today is large and much greater than it was before the War. We produce about two fifths of the world's coal, steel and cement, more than one half of its cotton and corn, nearly two thirds of its petroleum and about four fifths of its automobiles. In 1929, our share of the world's production of leading crops, according to Dr. Snyder, was 25 per cent, our share of the world's production of minerals and metals was 47 per cent, and our share of the world's production of all leading basic commodities combined was 33 per cent. With such a proportion

of the world's business, it would hardly seem that 35 per cent of the world's stock of monetary gold is a very excessive proportion for us; although it is probably somewhat more than we actually need under our normally highly efficient currency and banking system.

Our Stock of Monetary Gold and the Tariff

One common argument is, that we insist upon foreign countries paying us what they owe us and then, by imposing against them high tariff barriers, force them to pay us in gold. In this connection, particular stress is usually placed upon the so-called interallied debts. This subject is a big one and all I can hope to do here is to mention a few significant facts that should be taken into account in forming one's opinion upon it.

May I say, parenthetically, that, although, personally, I am not in sympathy with our American high tariff policy, I believe in "giving the devil his due" and I believe that the influence of our tariff is a small one on the world's distribution of gold.

The Hawley-Smoot Tariff went into effect June 18, 1930, in the midst of the current world depression, and it is, therefore, obviously impossible at this early date to pass a safe judgment concerning its influence on our foreign trade. The year 1931 witnessed a tremendous decline in the foreign trade of the whole world, the United States included.

The average rate of duty collectible on all imports, however, was not raised greatly by the tariff of 1930 and, according to the estimates of our United States Tariff Commission, was much lower than the average rate of our preceding six tariff laws beginning with the McKinley Act of 1890; the average for the 1930 tariff being estimated at 16 per cent, that of the 1922 tariff at 13.8 per cent, and that of the six tariffs ending with that of 1922 at 19.6 per cent.

The proportion of imports coming into the United States free of all duty is larger than that of most of the leading countries of the world. About two-thirds of our total imports during the fifteen years ending 1930 entered free of all

duty. While the rates of duty on many classes of goods for these years were high, the average rate of duty on all imports for consumption for the ten years ending 1930 was only about 14 per cent. In fact, the average *ad valorem* equivalent of duties collected on imports into the United States is substantially lower than in most countries. Doubtless one reason for the large percentage of our imports that comes in free and for the low average duties on all imports is the fact that the importation of goods bearing high duties is greatly curtailed. In other words, it is the free goods and the goods bearing low duties that come in. Still, it is significant to note that, despite our tariff, our imports averaged 17 per cent higher for the five years ending 1930 than for the preceding five-year period. Furthermore, our percentage of the world's total imports increased from 8.3 in 1913 to 12.4 in 1929; while for some years now our American import trade has been the largest of any country in the world, except Great Britain.

Interallied Debt Payments

Taking the interallied debt figures for the year 1930, which was a more typical year for these debt payments than 1929, and using trade and tariff figures for 1929, the last year before the world crisis, we find the following relationships between the amounts paid to the United States on interallied debts and the volume of foreign trade.

The total interallied debt payments to the United States were, in round numbers, $241,000,000, of which $54,000,000 were paid by France and $161,000,000 by England. The total interallied debt payments to us in 1929 were equal to only 5.5 per cent of our merchandise imports, or to 8.4 per cent of our non-dutiable or free imports. The interallied debt payments of Great Britain to the United States were equivalent to 4½ per cent of her total merchandise exports. Her debt payments to us were almost exactly equal to her non-dutiable merchandise exports to us. The interallied debt payments of France to us amounted to only 2.7 per cent of the value of France's total exports. They were just about equal to France's non-dutiable exports to the United States.

Of course, a debtor like England can pay debt obligations to the United States not only by increasing exports of goods and services to the United States and by decreasing imports of goods and services from the United States, but also by the more roundabout process of keeping her trade with the United States otherwise balanced and of making payments to the United States through the intermediation of other countries. England, for example, might pay us through exports of English cotton goods to Brazil, against the proceeds of which, payable in Brazil, Brazil would export duty-free coffee to the United States; or England might export woolens to France, the proceeds of which would be used up by American tourists in Paris.

Our high tariff—as every other high tariff in the world—and there are many of them today—is doubtless an obstacle to international trade and to the ready flow of international debt payments; but, in my judgment, its importance as a factor in the recent widespread breakdown of the gold standard has been greatly exaggerated in current discussions.

Flow of Gold to United States for Safety

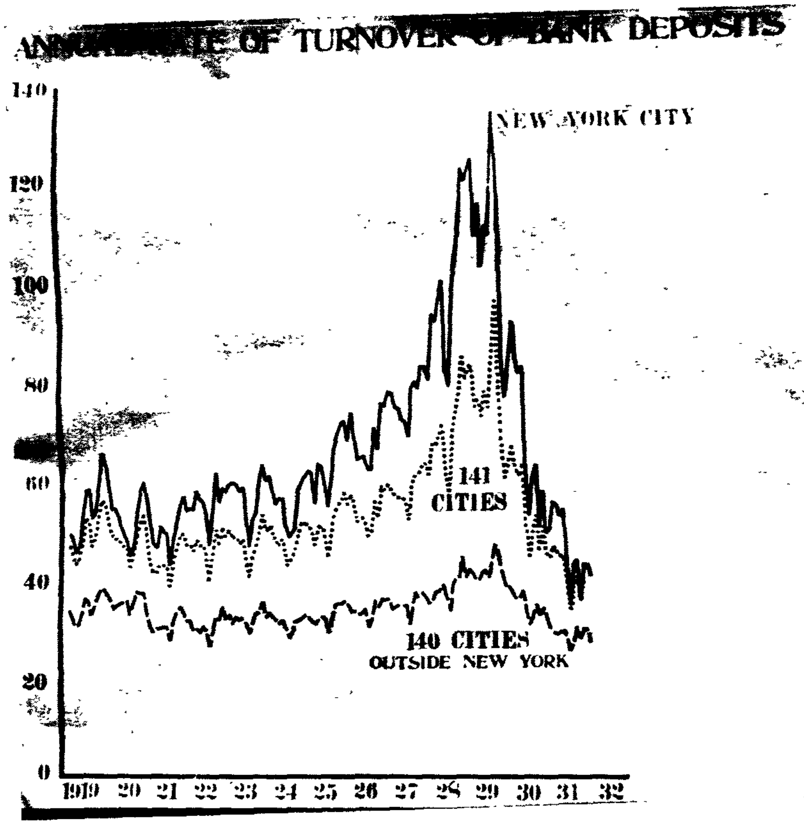
One important reason why our stock of monetary gold in the United States is so large as it is at present may be expressed in the term "Safety first." Given the collapse of 1929–32, with its resulting losses and widespread bankruptcies, with its aftermath of unemployment, of social unrest, and of political revolution throughout the world; it is not strange that people everywhere have become scared and have converted their capital into gold or its equivalent—the only thing they could see whose value was rising—and should have done their best to get these gold values quickly in the safest places they could put them—namely, on deposit in the strongest banks they could find in the United States and France, and in bank acceptances, government bonds and other high-grade liquid securities in these two countries. Funds have flowed to the United States and France in very large quantities for safe-keeping. Furthermore, large amounts that

flowed to the United States before the crisis, in connection with investments made here by foreigners for profit-making purposes during our boom speculative market, have remained in this country. This flow of investment funds has carried with it a flow of gold. The all-important consideration lately has been safety, not yield. Hundreds of millions of dollars of funds in the United States and France are serving as a storehouse of value for people all over the world, a function not greatly unlike that performed for the people of India by the numerous gold and silver hoards of that vast country. We did not seek this large supply of gold. Much of it was thrust upon us. Our Federal Reserve banks until recently maintained for some time the lowest discount rates in history, one reason being to prevent gold from coming to us in excessive quantities. Our federal reserve discount rates are still among the lowest in the world. Our gold market for many years has been an absolutely free one. Since 1919 the people of any foreign country (except Russia) having liquid assets in the United States have been able to convert them into gold at will and take the gold out of the country without restrictions. During the months of September and October last year, we gave up freely and without restriction to the rest of the world over $700,000,000 of gold—probably the largest commercial net outward movement of gold in two months' time from one country that the world has ever seen. Yet today our stock of gold is still the largest of any country in the world. Recent legislation, moreover, greatly strengthens our gold position and makes each dollar of our stock of monetary gold on the average much more efficient than formerly.

With business depressed and confidence lacking, the funds in many parts of the country have piled up in the banks. Savings deposits and other time deposits are large. Money in hoards is still estimated at high figures. Wholesale commodity prices were 32 per cent lower in March 1932 than three years before, while the index of the country's physical production was about 25 per cent less, the amount of money

officially reported as in circulation was 15 per cent more and bank deposits of reporting member banks were only 16 per cent less.

The trouble is that the people who have the money, the bank deposits and the bank credit are afraid to use them. They are afraid because so many times since the 1929 crash the optimists have had their fingers burned. For some



years before the crash of 1929 it was the pessimist who usually got burned. Money in circulation is turning over very slowly; likewise bank deposits, through which, by means of checks, we normally do something like 90 per cent of our business. Demand deposits in banks that are not moving are analogous to money that is not moving, namely, to

hoarded money. The average annual rate at which our demand bank deposits turned over in 140 leading cities in the United States, exclusive of New York City, declined, in round figures, from 42 for the year 1929 to 29 for the year 1931—a decline of 31 per cent. For New York City the corresponding two-year decline was from 112 to 46, or a decline of 61 per cent, and for all 141 cities the decline was from 78 to 41, a decline of 47 per cent.

Under such circumstances, a complaint that we have not enough money in circulation is analogous to a complaint that a country was suffering from a lack of freight car facilities at a time when the amount of freight to be carried was something like a fourth less than normal, when the number of freight cars was about a sixth greater than normal, the average speed at which the cars were moving was very much slower than usual and when a large percentage of the cars were being continually parked on the sidings.

The Commodity Price Level after the Depression

If the world is not experiencing an enduring shortage of monetary gold, and if I am correct in maintaining that the recent heavy decline in the commodity price level is due chiefly to psychological factors and to economic maladjustments of a temporary character, we may expect that, within a short time, the fundamental forces which make for a fairly uniform rate of secular economic growth in the world as a whole will again dominate the situation. In that case, if the world continues to use the gold standard, as I believe it will, the commodity price level will probably rise to something like what it was during the 8½-year period of comparatively stable wholesale prices which ended with the stock-market crash of late 1929.

In this connection, it is interesting to note that the Graph for the movement of American wholesale prices between 1896 and 1913 rose at the rate of 2.4 per cent a year (geometric), and that if this graph were extended in a straight line to 1929 (as it is on Chart I, Graph E), it would be very close to the

actual commodity price level Graph for the years 1921 to 1929. In fact, it would give an average price level for those nine years only 5.3 per cent higher than the actual price level. In other words, had there been no war, and had wholesale commodity prices in the United States risen on an average 2.4 per cent a year progressively from 1913 to 1929, which is the percentage rate of annual rise from 1896 to 1913, we would have had approximately the same average price level from 1921 to 1929 that we actually did have. This price level, moreover, like the actual price level, would have been (as shown on Chart I, Graph E and Chart II, Graphs A and B) very close to the level represented by the Graph for "the world's supply of monetary gold relative to the world's production of basic commodities."

The great fundamental forces which determine the long-time swings in the world's price levels have not been greatly changed during recent years. The world's population and the distribution of this population are practically unchanged. Human tastes, human wants and human capacity to labor are essentially what they were three years ago. There is no reason to believe that the world's annual rate of increase in the production of basic commodities—a rate of about 3 per cent a year—which has persisted for two generations has suddenly been changed permanently. Gold production has increased substantially since 1921, and since 1913 the world's supply of monetary gold has increased faster than the world's production of basic commodities; while the efficiency of gold as the basis of our credit structure is being increased continually through improvements in our currency and banking machinery. If, since our 8½ years of comparative stability in commodity prices ending in 1929, nothing has happened to change fundamentally and permanently the world's supply of gold and circulating credit and if, likewise, nothing has happened to change fundamentally and permanently the world's production of basic commodities, its system of fabrication and marketing, and the number and character of the human beings that handle its economic machinery, it

would seem probable that a commodity price level something like that preceding the crisis would return when we once drag ourselves out of this slough of despond.

Moreover, the discontinuance of the gold standard recently by so many countries, with the resulting decline in the demand for gold, will tend to cause gold inflation—in other words, to stimulate a rise in prices in gold-standard countries. If a substantial part of the world should long continue off the gold standard, we may even witness a rise of commodity prices in gold-standard countries to a higher level than that preceding the crisis.

The Monetary Standard of the Future

But will Great Britain, the Scandinavian countries and the numerous other countries that have abandoned the gold standard during the present world crisis return to the gold standard when the depression is over? The answer, I believe, is "Yes."

Many countries are still on the gold standard, including the United States, France, Belgium, Holland, Italy, Poland, Switzerland, the Union of South Africa, and (with some qualification) Germany; and all these countries declare it to be their firm intention to continue on the gold basis. Wherever the gold standard has been given up during the last three years, it has been given up, as it was during the World War, under the pressure of a great crisis, and not for the purpose of permanently substituting some other standard in its place. In every country that has suspended gold payments, the suspension has been looked upon as an unfortunate but only temporary emergency measure, and in every case the predominant expectation on the part of the governing authorities and of the public is that the gold standard will be reëstablished when the present world economic crisis is over. There is little sentiment in the world today for any other standard, such as the silver standard,

the bimetallic standard, or some form of the tabular standard, permanently to replace the gold standard. Most of the agitation for a so-called managed currency standard contemplates a managed gold standard, and not a managed paper currency disconnected with gold.

With all its faults—and it has many—the gold standard in the judgment of the world is the best standard with which the world has had extensive experience. For the present, at least, and probably for many years to come, the world's expectation and best prospects for a reasonably good monetary standard lie in the improvement of the gold standard, rather than in any substitute for it that has yet been devised. In this connection, we can well subscribe to the conclusion of the famous Macmillan Commission of Great Britain, published under date of June 23, 1931, three months before England went off the gold standard, that, "There is, perhaps, no more important object within the field of human technique than that the world as a whole should achieve a sound and scientific monetary system. But there can be little or no hope of progress at any early date for the monetary system of the world as a whole, except as the result of a process of evolution starting from the historic gold standard."

The world, in my judgment, will slowly but surely return to the gold standard after this crisis is over, just as it did after the World War. In a few years' time most of the world will be as sick of managed paper currencies as it was twelve years ago. The main trouble will be that popular ignorance and lethargy, coupled with selfish special interests, economic and political, will, as in so many of the world's paper money experiences in the past, force politics into the management and the management into politics. This will spell inflation and currency breakdown. Politically speaking, the world is yet far from being ready for managed paper currency standards.

The gold standard has long been to some extent a "managed" standard and has been increasingly so in recent

years. It will probably be managed even more in the future than it has in the past. All currency management has its dangers. But, taking human nature and present-day politics as they are, the world for a long time to come will have more confidence in a gold standard managed with the coöperation of the world's great central banks than in any form of managed paper currency disassociated with gold.

INTERNATIONAL FACTORS IN THE BUSINESS DEPRESSION

By ERNEST MINOR PATTERSON

Last year I presented a paper to this gathering under the title, "Economic Adjustments in a Machine Age," and it is from the conclusions of that paper as a background that we can best approach the topic assigned for today. Briefly stated, those conclusions were that our machine age is one of growing instability, that intelligently planned adjustments are of increasing importance but of tremendous difficulty, and that we must, if possible, find a substitute for the "invisible hand" guiding the "economic man."

There are so many factors in the present business depression, even in the international field, that they cannot well be outlined adequately in thirty minutes. It will therefore be better to develop one aspect of the situation, choosing that which is presumably of greatest importance to Americans. It rests on two general conditions. One is the broad background of a highly dynamic, rapidly changing machine age. The other is the new relationship between the United States and other parts of the world arising out of the World War and these early post-war years.

American economic history for the last one hundred and fifty years has brought three significant changes. First is a growth in population from some three million persons or less to the present one hundred and twenty-five million. The second is a great extension of the absolute area of the country through successive additions of territory, an increase more than offset by the larger population just mentioned. As a consequence population density is now about forty persons per square mile. In other words, there has been a decline in land area per capita. There is little actual congestion but

there are enough people in our country to create certain problems. Thus, we have high land values and single tax movements, labor unions and other phenomena that indicate a population numerous enough to raise difficult public questions. The third change is the increase in our supplies of capital, until we are now by far the richest country in the world in the aggregate and on a per capita basis.

This development was facilitated by the fact that in the earlier years of our history we hastened our growth by borrowing heavily from abroad. We sent to the people of other countries shipments of foodstuffs and raw materials whose value was far less than the value of the commodities that were imported. This excess of imports year by year was possible because European investors were willing to purchase American mortgages, stocks and bonds. The United States was an immature debtor with an economic structure adjusted to that stage of its development.

As the years passed the accumulation of foreign investments here became very large and the amounts due for interest payments were great enough to affect our foreign trade. Moreover the disappearance of our merchant marine and the fact that our trade with other countries was carried in vessels owned by foreigners made necessary the payment to them of freight charges. Together with miscellaneous other items the total of our obligations to the people of other countries for imported goods and services became greater than the total of their obligations to us for goods and services that we exported to them. This change appeared as an excess of exports. Both exports and imports had increased but the exports were the larger. Just before the War exported commodities were valued at about $500,000,000 a year more than the imported commodities.

These changes had come slowly and the necessary adjustments had been gradually made with a minimum of strain. The tempo was quickening somewhat but adaptations were not proving difficult. Foreign investments here were continuing but investments by us in other countries were growing.

We were a matured debtor country with an appropriate excess of exports and were beginning to feel our way into the next stage—that of the immature creditor country. This stage is one of growing exports and tends to continue until the investments abroad become so large that incoming payments on account of interest and dividends bring an excess of imports over exports.

Perhaps it is well to observe that this suggestion of different stages of national development may give an air of fictitious simplicity to our recital, but the tendency we have pictured was there. In 1914 the United States was still a debtor nation with its structure adjusted to that relationship. Its farms and factories, its purchases and sales, all of the intricate machinery of its economic life, were constructed and geared to this fact. Adjustments were constantly being made to fit changing conditions but they were relatively minor ones and were accomplished with only moderate strain.

From 1914 to 1920 the pressure was one that rapidly increased exports and tended to restrict imports. Other countries could send us only moderate shipments and could render services only in a restricted way. We were urged to export our commodities in large volume for war and other purposes, to build a merchant fleet and in every other possible manner to relieve our associates in the war. We did so and increased enormously our capacity to export goods and services, making no effort to adjust ourselves to the receipt of more goods and services from abroad. Our whole economy was adapted to this situation and when 1920 arrived we faced a new relationship to the world for which we were entirely unprepared.

We had become creditors—indeed, we were creditors to such an extent that the pressure to receive payments was heavy enough to constitute an acute problem. For six years adjustments had been made chiefly by an inflow of large amounts of gold, by the resale to American buyers of American securities previously held abroad and by the sale in the United States of a large amount of new foreign obligations.

These latter included the now famous (or infamous) inter-allied debts due to the United States Government from numerous foreign governments.

We had been changed from debtor to creditor status. Such shifts in relationship are not new but ordinarily the change comes gradually with decades of time for adaptation. For us it came quickly and at a time when the pressure of local patriotism and of world demand was driving us into an expansion of exports and restricting our imports. Suddenly to reverse our status was entirely impossible.

This may be made clear by indicating what such a reversal would have involved. It would have meant a decrease of exports or an increase of imports or any combination of the two which would have made the imports the larger. Exports might have grown absolutely but imports would have had to grow still more if the adjustment was to be accomplished.

Consider first a curtailment of exports as the method to be followed. We have been speaking in broad terms but after all trade is in specific commodities. A reduction of exports would have meant the sale abroad of less cotton or wheat or automobiles or something else. But our industries were equipped to sell not only at home but abroad. For any one of them a reduction of foreign sales would have necessitated a corresponding development in the domestic market or a curtailment of operations—perhaps a dismantling of plant. For many farmers it would have meant a shift to new lines of production or the abandonment of farms—for manufacturers a readjustment of sales organizations and of plant or the discharge of workers, defaults on obligations and bankruptcies.

The alternative was an increase of imports. Within limits this was possible and occurred. American travel abroad was stimulated and aided materially. Tropical products and raw materials not produced in the United States were imported in larger amounts. But there were limits to this movement. Any sharp increase in importations of manufactured goods would have caused trouble because many of

the imports would have been of products competing with established industries here. In the absence of a greatly enlarged domestic market, *e.g.* for textiles, the strain would have been very great.

We are talking as though this situation were intelligently analyzed and decisions carefully reached. Of course this was not the case. The forces we have described were there and had their influence. But such national action as we took was not the result of a general analysis and a carefully formulated decision. Instead, there were a variety of happenings unrelated, at least in their planning, but with curious consequences.

These actions may be described in two groups. The first of them included among other things our continued effort to maintain and to expand exports. Private efforts of business men were supplemented by the efforts of our Bureau of Foreign and Domestic Commerce and assisted by the utilization of special legislation, including the Webb Act and the Edge Act. We sold large quantities of goods abroad, thus placing on the people of other countries the obligation to pay. The amounts, of course, varied but in 1929 we exported $5,241,000,000 of goods. To this we added our insistence that foreign governments pay us in that same year $212,000,000 and we expected a payment of perhaps $876,000,000 on our private investments abroad—a total on all three items of $6,329,000,000.

On the other hand, we took several steps that made settlement more difficult. One form of payment is immigrants' remittances. We have thought it wise to restrict immigration, a procedure which tends to reduce this item. We have developed and have given specific aid to our new merchant marine, lessening the amount of services which foreigners might otherwise render to us. Instead of insuring our properties with foreign companies and doing our foreign financing largely through London, Paris and Berlin, to whose bankers we would pay commissions, American insurance companies and banking houses perform these services for us

to a greater extent than formerly. In 1921, in 1922 and in 1930 we revised our tariffs upward, increasing the restrictions upon the importation of foreign goods. In other words, we demanded heavy payments but interposed numerous obstacles to the making of the payments.

An easy reaction to this is to comment harshly about the greed or the stupidity of our political leadership or of the business interests concerned. But such an approach is altogether too simple and overlooks the inherent difficulty of our position. To repeat, our entire economy was highly geared to our status as a matured debtor or as an immature creditor, a relationship calling for an excess of exports. We had suddenly become creditors on so huge a scale that a readjustment would have been helpful.

We have easily pictured the difficulties of such a change and we need not be at all surprised that it was not made. The solution actually reached—if this is the correct term—was a continued excess of exports, the difference being cared for by private American investment in foreign securities. The Department of Commerce estimate for these private long-term investments was $15,134,000,000 as of January 1, 1931.

There are many complexities and details that might be added, but we lack time and in any case their inclusion might be confusing rather than helpful in an attempt to keep certain broad considerations to the front. We have "carried on" since the war in such a way that the needed readjustments have not been made. Instead, the year 1929 found us with a problem that had, on the whole, been seriously aggravated by the delay. In that year our exports were $842,000,000 in excess of our imports and accumulated foreign obligations meant a demand by us for approximately $1,000,000,000 as interest and as repayment of principal. Only by buying ever larger amounts of foreign securities could we go on without difficulty. It was only a question of time when the break would come.

In 1932 we face a situation much worse than that of 1920.

It would be possible to add references to a large number of complications arising out of conditions in Europe, in Latin America and in Asia, but we are attempting to keep certain large matters clear. What may be expected for America?

First, we may fairly assume that for the present foreign securities cannot be readily sold in our markets. There will probably be a period of several years during which that form of relief will not be available. In the long run this may be fortunate but the immediate consequences are tragic.

Second, there will be a continuing pressure of imports. Payments are due us and there will be a strong tendency for them to come—a tendency which will be opposed by those interests in the United States who suffer from the competition. Already there are active efforts to increase the tariff barriers and more are to be expected.

Third, there will be a continued intense competition in ocean transportation. Merchant fleets are large, much trade is languishing and rivalry will be keen if not bitter. In this situation our enlarged merchant marine is an important factor.

Fourth, may be mentioned the obstacles to our export trade. Conditions everywhere, including the United States and our unadjusted relationship to others, will combine to make our sales abroad very difficult. With our obstacles to the imports which would otherwise furnish to foreigners in larger quantities the dollars they need if they are to make payments, and with our unwillingness to buy securities which would likewise supply them with dollars, they cannot readily pay for our goods. At the same time, many of them are debtors and must make every possible effort to sell their goods.

Fifth, a renewal of gold imports may be expected. The recent outward movement is due to temporary influences. We are under pressure to receive something. If we hesitate to receive services and other commodities, the value of the dollar in foreign currencies will rise to the point where gold will press in. Our economy is so adjusted that large amounts

are due us from abroad. The attempts to pay will express themselves in a demand for dollars. Quotations for dollars will rise in terms of other currencies and as gold points are reached gold will tend to flow in. Suspension of gold payments in many countries will, of course, modify this, but the tendency will still be present.

Sixth and last, we can hardly expect that under such a combination of influences as we have sketched it will be possible to avoid many defaults in our foreign investments. Many have already come and more are to be expected. Payments simply cannot be made. Some of the so-called investments were unwise and some transactions may have been entirely fraudulent. On these the losses are huge. Then, too, there are many borrowers whose ability to meet their obligations has been destroyed through the fall in prices. But in addition there are numerous difficulties arising out of America's peculiar position. It is hard for others to pay us if we resist payment. Worded in daily business terminology, our debtors will find it difficult or impossible to find the dollars with which to pay even if they are in a solvent condition in their own countries. On our side readjustments are hard for the reasons already stated.

To this point we have spoken primarily of factors growing more directly out of the war and early post-war situation. The second element is that these troubles are appearing in our highly developed machine age. "Rationalization," defined in its broadest way, proceeds with leaps and bounds. Scientific management and business efficiency are broadened to include countless methods for reducing costs, increasing output and substituting machines for men. Changes are appearing with ever greater rapidity, first in one industry and then in another. Some develop more than others. Whole countries, in fact whole regions, lag and then forge ahead. Large scale investments with their heavy overhead costs add to the intensity of the competition. Under such conditions stability is needed more than ever before, but is harder than ever to attain.

One expression of this involved situation is the efforts of debtor countries to meet their obligations by restricting imports in every possible manner and at the same time encouraging exports. Yet creditor countries, notably the United States, feel constrained to follow the same policy. Since it is not possible for all countries at any given time to export more than they import, something must give way.

We have already suggested six tendencies that may be expected. Are there any steps that may be taken to lessen the strain and reduce the losses? Whatever we do must clearly be designed to meet the situation that we have analyzed. In general, our efforts should be planned, first, to minimize the losses brought on by our failure or our inability to make our adjustments sooner; and, second, to facilitate the adaptation of our national economic life to our new situation.

Some losses cannot be prevented. Recent revelations have made it clear that many of our foreign investments were made carelessly; others were made by methods at least open to serious question; and still others were sold to the public on the basis of entirely false statements. We cannot hope that such errors as these can now be offset and no losses sustained.

There are, however, many foreign debtors who are unable to pay, first, because of the serious decline in the price level and, second, because of the restrictions imposed by their own governments and by business conditions upon the available supply of foreign exchange. The first of these two groups will be materially aided by a rise in prices and any steps that we can take to prevent further declines or to stimulate an advance will lessen the number of defaults. Apparently the people of the United States are now quite aware of this need, although it is by no means certain that we are sufficiently in agreement regarding the devices that should be employed to accomplish the result.

The shortage of foreign exchange which hampers many debtors, including purchasers of our current exports as well

as those whose bonds we hold, is closely connected with a large number of highly involved and interrelated problems. Among them are the inter-government debts. In 1920 they were, perhaps, the largest complicating factor. Today the annual payments they call for are less than those on several other items in our international balance of payments, but they stand out from the rest because they can be so readily cared for if we can only make up our minds to do so.

It is highly unfortunate that the opponents of the cancellation of these debts have gained the impression that the advocates of such action are merely sentimentalists. Many of the advocates have from the start viewed the matter with a very cold detachment and have been contending that insistence on payment would bring economic losses far more serious than would cancellation. There are more people in the United States now than ever before who share that view. If the debtor countries repudiate, as some of them may, the shock to them and to ourselves will be far more serious than if the United States takes the initiative. The political formula that may be invoked to bring cancellation or to disguise it is far less important than the result. Every dollar lost by such action will result in the saving of more than a dollar of the private indebtedness—a saving not only to a few rich bankers in Wall Street but to many people of moderate means throughout the country and to the rest of us through the general stimulus to business that such an action would furnish.

Closely related to these efforts designed to minimize our immediate losses are the measures needed to facilitate our better adjustment to our new creditor status. As we have already pointed out, our problems have become aggravated by our delay since 1920. Further hesitancy will make them still more serious, while errors in our decisions will make our losses still more severe.

Again, it is not hard to indicate the goal toward which we must move. It is to readjust our structure in such a way and to such an extent that we shall have an excess of im-

ported goods and services over exported goods and services. We may conceivably follow the advice of those who are urging that we withdraw from our foreign commitments and live in a more self-contained manner, but the probabilities are very strongly against it.

To discuss now the many and varied issues that are involved is impossible. Among them, however, several may be briefly enumerated:

First. Obstacles to imported goods should not be increased by higher tariffs or otherwise.

Second. Efforts should be promptly made through international conferences to secure reciprocal action in reducing tariffs throughout the world.

Third. Adjustment of the dangerous rivalry between the various national merchant marines is much needed.

Fourth. New investments abroad should be made in smaller volume and with more discrimination and for productive purposes. The concept is a difficult one to apply but in recent years it has been unnecessarily ignored.

There is no magic process by which these and other readjustments will be secured. In the United States results will probably come in part through the growing power of two groups—the exporters who are beginning to realize that foreign buyers can pay only if they can secure dollars; and the investors who are more and more conscious that debts to them also can be paid only with dollars. Both groups are increasingly aware that they will lose unless the volume of imported goods and services is enlarged. Their combined efforts may have some influence on our public and private action and hasten our adjustment. Nevertheless, it will come slowly.

IMPROVEMENTS IN BANKING PRACTICE SUGGESTED BY THE PRESENT DEPRESSION

By GEORGE W. NORRIS

It is almost mathematically accurate to say that during the last eleven years there has been an average of 27,000 banks in existence in the United States, one third of which have been members of the Federal Reserve System, and two thirds non-members. About 30 per cent of this total number of banks were national banks, chartered and operating under the National Banking Act, and about 70 per cent were state banks, chartered and operating under the laws of some one of the forty-eight states of the Union.

During this same period 9,285 banks closed their doors, with aggregate deposits in excess of $4\frac{1}{4}$ billion dollars. Of these 9,285 banks, 1,698 were members of the Federal Reserve System, and 7,587 were non-member banks. Of the 1,698 member banks, 1,333 were national banks and 365 were state member banks. Seven eighths of all these banks had less than $100,000 capital. Although the average mortality among the non-member banks was more than double that among the member banks, the mortality even among the latter was so high as to leave no room for doubt that there is something radically wrong with our banking system. This conclusion is confirmed by the fact that during the same period there have been scarcely any bank failures in either Great Britain or Canada.

If we ask experts for an explanation, we shall receive a great variety of answers. The three most frequent, however, will be "too many small banks," "lack of real banking knowledge among bank officers and directors," and "insufficient examination and supervision." Practical bankers

will cite a number of other contributing causes—day and night banking; carrying unprofitable accounts without a service charge; borrowing money to lend; soliciting deposits of public funds, with the obligations, political and otherwise, thereby assumed; making real estate and capital loans; insufficient credit information; and a host of others.

Let us pass by these latter, and consider the three causes of bank failures which are commonly regarded as the most important. First, "too many small banks." In both Great Britain and Canada, small communities are served by branches of large metropolitan banks. In this country, we have jealously preserved the "independent local bank." This is not surprising. It is in accord with our national temper and spirit. We are believers in state rights and local self-government, and we have—perhaps not without reason—a very distinct prejudice against "the money power" and against trusts and combinations. It is plausibly argued that the people of a community, whether it be large or small, prefer to entrust their money to a bank officered and directed by men whom they know and trust, rather than to strangers; and that they prefer that the extension of credit should be by men who know and trust them, rather than by a "manager" of a branch of a bank at a distant point. I am not here to combat this view, or to say that the policy is wrong. I do say, however, that if the people want these small independent banks they must be prepared to pay a heavy price for them in the future, as they have in the past. It is almost impossible for such a bank to diversify its risks. Its life is dependent upon wheat, or cattle, or cotton, or corn, or some local industry. Its loans are all local loans. It rarely has in its organization the talent necessary for the selection of a judicious line of investments. Its operations are too small to enable it to pay for competent management. It is usually a "one man concern." The wonder is not that so many of these small banks have failed, but that the number has not been greater.

Lack of banking knowledge is the second cause generally assigned. In these small banks the president—serving at a

nominal salary—is often a respected lawyer, a successful merchant, or a "good mixer," who is popular in the community and likely to attract deposits. The presidency of the bank is a "part-time job" with him. The real executive is a vice-president or cashier, who is "good at figures." The board of directors is apt to be composed of a farmer, a physician, a real estate man, an insurance agent, and one or more others, selected not for banking knowledge but either because they have subscribed liberally for stock, or because they, too, are "popular." The capital stock is paid in, and two or three hundred thousand dollars of deposits come in. What shall they do with the money? Loans are made to A, B, and C, generally with little or no regard to the ability of the borrower to pay his note at maturity, but on the strength of the fact that he owns a mill, or a home, or a farm, which is worth more than the amount of the loan. Such a loan is regarded as "safe." As an investment it probably is safe, but it is not a loan which can be collected at maturity. Its collection would probably involve "selling out" the debtor, and that could not be accomplished in time to meet any sudden withdrawal of deposits. What experienced bankers call "liquidity"—the ability to realize promptly upon loans or investments—is an almost unknown quantity to the small town banker. He is under constant pressure to be "a good fellow," and to "help develop his community." His investments in bonds are too apt to be simply the acceptance of the suggestions of a bond salesman who has gained his confidence or his personal friendship. Everyone connected with the bank wants to "see it grow," and unprofitable accounts are accepted, free services are rendered, and risks are taken.

When a bank closes, the indignant depositors are apt to ask, "Why did not the examining authorities ascertain the condition of this bank long ago? Why did they let it stay open and take our money? There must be something wrong with the system of examination and supervision." They are partly right, but only partly. National bank examinations,

in many banks, are necessarily rather superficial, owing to what I think is a mistaken basis for the charge for such examinations. In this state, and many others, the charge assessed against a state bank for examination is based upon the time it takes to make the examination. This is not only a fair and reasonable basis, but one which is in relief of the bank whose books, records, and securities are all in good order, and penalizes the bank whose housekeeping is slovenly. The Comptroller of the Currency, however, charges $75 for the first $25,000 of assets of the bank examined, and 3 cents for each $1,000 additional. The total charge for a bank with $500,000 of assets would therefore be $89.25, regardless of the condition of its records, the character of its assets, or the time consumed. In the case of the majority of banks, it is not sufficient to pay for more than a cursory examination. Except where a bank is put upon a special list, the Comptroller's examinations are made only twice a year, and in this state, in the past, examinations by the State Banking Department have generally been even less frequent.

It is therefore a fair criticism that many of the national examinations have not been sufficiently thorough, and that in many jurisdictions the state examinations have not been sufficiently frequent. It is doubtful, however, whether any examinations would materially reduce bank failures, unless conducted with such ability and thoroughness as would make their cost prohibitive. The number of failures resulting from dishonesty or from some one mistake or loss is extremely small. In nine cases out of ten, a bank failure comes either as the end of a long period of poor management, or because there has been a practical failure of the community in which the bank is located. It is not possible to say that it was the result of any one act, or that the cause of the failure occurred at any one time. It is a gradual culmination, often precipitated by a loss of confidence in the bank by its depositors. Examining authorities may have noted bad practices or poor judgment, and called these matters to the attention of officers and directors, but they are naturally reluctant to

close a bank which is not actually insolvent, and which still has a chance, by amending its practices, to recover lost ground. To close a bank is a great injury to the community it serves, and inevitably causes a further shrinkage of its assets in liquidation. Many a bank, temporarily in a dangerous situation, has pulled through and become strong and prosperous. One very great improvement is contemplated in an Act now before Congress, providing for the removal of an incompetent or dangerous officer or director. Experience has demonstrated that in many banks there is an officer or director of dominating personality who uses the bank for purposes of his own, or whose views and policies are dangerous. Heretofore, when such an official was supported by a majority of the directors there was no way to get rid of him. A power to do so would seldom have to be invoked, but its existence would contribute materially to greater safety in banking.

The foregoing is an attempt to state the present situation. What improvements are possible? If I were addressing an exclusively banking group I should suggest various practical details—adherence to regular banking hours; elimination of unprofitable accounts and expensive services; current credit files; insistence upon the required notice for the withdrawal of savings deposits; economy in bank premises; and a number of others. But today I want to discuss some matters more fundamental. A banker was waggishly defined some years ago as "a man who accepts money on deposit without interest, and loans it at interest, and places both depositor and borrower under obligation." More recently this definition has been altered, with perhaps less wit but with certainly more truth, to read "a man who receives money on deposit at the highest rate of interest the depositor can extract from him, and loans it at the lowest rate the borrower can induce him to accept, and places himself under obligation to both parties." This alteration is the direct result of excessive competition. In the race for business, banks have paid such high rates of interest that, to leave a margin of profit, they have been driven to the necessity of making some loans at

very high rates, and of buying bonds that yield high returns. Manifestly, such loans must involve a considerable degree of risk, and such bonds must necessarily be of substandard grade. Even so, the margin of profit is often insufficient to take care of the losses that must, in the very nature of things, be suffered by anyone who is a continuous lender. The first requisite for improvement, therefore, is an elimination of this excessive competition. Consolidations and liquidations—voluntary and involuntary—have already done much in this direction. The number of banks in this country today is probably not over three-quarters the number ten or twelve years ago. It is to be hoped that the involuntary liquidations are now almost completed, but the consolidations and voluntary liquidations must continue, and it is to the public interest that they should continue. And it is very earnestly to be hoped that neither the national nor the state authorities will in the future grant a charter to any bank unless its projectors can show that it is needed to serve the public convenience. Much the same tests should be applied that the Interstate Commerce Commission applies to an application for the construction of a railroad, or that Public Service Commissions apply to an application for a competing public utility. Bank charters have been granted in the past with much too great liberality. The effect has often been merely to substitute two weak banks for one strong bank. Banks must be run, and their policies dictated, by their officers, and not by their customers. To accomplish this, there must be some limitation on competition.

There must also be some considerable extension of branch banking. I do not think that a provision for state-wide branch banking would answer the purpose. Trade and commerce do not recognize purely political boundaries. Just what limitation should be fixed, it is difficult to determine in advance. The Comptroller of the Currency has made a very reasonable suggestion that the establishment of branches be limited to defined "trade areas." It might be made allowable for a bank to establish branches in its own or an

adjoining state. There are two things to be avoided—first, nation-wide branches, that might result in one or more giant banking institutions, whose existence would not comport with our institutions and ideas; and, secondly, the forced elimination of sound local banks by unfair competition. A law establishing geographical limitations would avoid the first danger, and the establishment of a supervisory board, invested with powers similar to those exercised by the Federal Trade Commission, would seem to be adequate protection against the latter. However this may be, the fact remains that the people of this country are squarely up against the alternative of an extension of branch banking, or a continuance of the frequent failures of small banks in one-industry neighborhoods. They must make their choice between the two.

The fundamental difficulty with the American banking situation, however, lies in the fact that we have approximately 6,300 national banks, and approximately 13,800 state banks, competing for the deposits of the public, and dividing them almost equally between them. The national banks operate under Federal charters, their operations are controlled by Acts of Congress, and they are examined by the Comptroller of the Currency. The state banks operate under a state charter, their operations are controlled by state laws, and they are examined by the banking departments of their respective states. Congress has no power to deny to any state bank any power, authority, or privilege given to it by the laws of its state, unless it voluntarily subjects itself to Congressional control by becoming a member of the Federal Reserve System.

What is the result? Congress fixes certain wise and conservative rules as to adequate reserves, as to the distinction between time and demand deposits, as to the character of business that may be done, as to the amount that may be loaned to any one borrower, and various other matters of that sort. These rules bind all national banks. Then certain states "liberalize" their banking laws, permitting their state

banks to do things forbidden to the national banks. Immediately the national banks make representations to Congress that they cannot compete with the state banks in their states, unless they are given the same privileges, and Congress proceeds to "liberalize" the National Banking Act. Or, conversely, Congress, discovering the existence of certain bad and dangerous practices, threatens to legislate against them, and immediately the national banks declare that if this is done they will not be able to compete. Or again, if Congress takes the initiative in liberalizing the National Banking Act, the state banks memorialize their respective Legislatures—generally with success—for a similar liberalization of the state law. There is thus set up a very distinct competition in bad banking, in which Congress and the State Legislatures seek to outdo each other.

Lincoln declared that our government could not permanently endure half slave and half free I would not go so far as to say that the American banking system cannot endure half national and half state, but I have no hesitation in saying that this dual system is the greatest obstacle to good banking in this country, and that we shall never have a thoroughly sound and satisfactory banking situation as long as this competition continues, with its rivalries, jealousies, and divided responsibilities.

I realize that a correction involves serious constitutional difficulties, but in view of the lengths to which the taxing power, the police power, and the right to regulate interstate commerce have already been carried, I should not suppose that these difficulties would be insuperable.

DISCUSSION

By FRANK W. TAUSSIG

THIS being a Philosophic Society, I venture to philosophize a bit. I shall not comment on the admirable papers which have been read, but say something about the state of our knowledge of the problem at large, and about some special difficulties under which the economists labor.

A parallel can be drawn between the labors and perplexities of the economists, on one hand, and the doctors, on the other. The most tragic thing confronting the doctors is cancer; and it is also that about which they are most helpless. The disease is unsparing of age or sex or station. It seems to be on the increase. Yet the profession hardly knows what to do about it. No preventive is known, no cure. The knife, if used at an early stage, may remove the degenerated tissues for good; but too often it fails to do so, and merely prolongs a life of suffering.

This is not to say that the doctors are ignorant about cancer. They have carried on a great range of observations and accumulated a mass of information, and much has been learned. They seem to be agreed that it is not a germ disease. They know quite certainly that there is not one type only, but several, perhaps many, and that the modes of occurrence and growth and malignancy are not the same for all types. But for all the advance of knowledge and technique, no preventive is known, nor any cure.

Much the same sort of thing can be said about the economists and business crises. Crises and depressions may be characterized as the dread disease of the economic body. It strikes rich and poor, deserving and undeserving. I am not at all sure that, as some people say, it is on the increase, but I see no indication that it is decreasing. Yet when it

comes either to preventive or to remedy, the economists are able to offer little that is positive or certain. We should probably be in agreement about some things that would help both in the way of prevention beforehand and of palliation afterwards. But we are not at all sure about the cause, and still less sure about the cure.

True, like the doctors, we are not quite helpless, and we are by no means ignorant. An enormous amount of research has been directed to the problem and an enormous amount of material has been accumulated. We know that there are marked repetition and sequence in the disorder. We know that there is not one simple phenomenon that repeats itself, but phenomena of a very varied sort,—of this more in a moment. Yet, great as is our volume of information, highly expert as is some of our theoretic work, sure as we are in our criticisms of sundry palliatives and remedies, we too, are in no agreement about prevention or cure. On these essentials of the problem we are in no better state than the doctors are about cancer.

There are differences, however, as well as resemblances. The differences are of two sorts: one, as to the methods of inquiry that must be followed; the other, as to the results to be expected from those methods of inquiry which alone the economist can follow.

As regards methods and tools, the doctors obviously are in a more favorable position than the economists. They can experiment; the economists cannot. The distinction is familiar. It runs between the work of all the social sciences, on one hand, and many, if not all, of the natural sciences, on the other hand. It is true that the doctors cannot experiment in the same way or with the same assurance as can the chemists or physicists or the biologists. Their experiments, except in rare cases, cannot be applied to man directly. But they can be applied to creatures other than man, whose make-up is so similar to man's that significant clues are derived and sometimes assured conclusions. The doctors are not quite certain that the cause, the course, the prevention of a

given disease is the same with rabbits and rats as it is with man. But important truths are not only suggested, but often established by experimentation on animals.

The economist, on the other hand, to all intents and purposes cannot experiment at all. He is in the position of the geologist and the meteorologist. Like these, he can do little more than observe the confused mass of phenomena which the complex operations of nature present to his view, and detect among them by continued and discriminating observation such regularities as they present. In all the disciplines that rest on observation the task of science is a long and weary one, and inevitably lacks the certainty of conclusion which is reached by controlled experiment.

No doubt the doctors must observe also. This indeed is all that they were able to do until, within the last half-century or so, biology taught them to experiment on living creatures. They must still observe, and in particular as regards the application to human beings of the results of animal experiment, they must carry on extended and difficult observation. Therein their doings are not so markedly unlike those of the economists and sociologists and political scientists. They stand in a somewhat intermediate position.

The observations of the doctors, however, have one favoring condition which is not present in the social sciences. The doctors have to deal with the phenomena of the natural world, which are regular and repeat themselves in an unchanging sequence; whereas the economists have to deal with phenomena that are highly irregular and repeat themselves, if at all, with perpetual modification. True, the contrast can be overdrawn. The phenomena of health and disease do not repeat themselves with absolute regularity. Cancer, for example—I repeat what the doctors tell me—is by no means a single thing. But any one kind of cancer, such as carcinoma, wherever it appears, is always the same thing. So it is with the structure of the heart and the relation of disease to its structure; so with embryology and the growth of the foetus. These things, once observed accurately, are known; they are

found again without essential change in a subsequent case. But we economists have to deal with things that are changing all the time. No two sets or instances in the same range of phenomena repeat themselves with anything like essential regularity. Price changes, upwards or downwards, have been of a different character in the period since 1923 from what they were in the period following 1903. Or, to come more directly to the subject of the present discussion, crises and depressions are by no means all alike. The sequence of events varies, and the indications of cause vary. What we might infer as to causation from the observations of one crisis is by no means readily applicable to the observations of another crisis. The present cycle and the present crisis are in many ways unique. The phenomena of depression itself perhaps change least; they are sadly alike from case to case, from decade to decade. But the incubating period, the course of events in the years preceding collapse, is by no means a constant. Both as regards monetary and financial conditions, the development of international trade, the course of prices, the changes in the technique of industry,—in many important particulars, the years before the crisis of 1929 were different from anything this country has ever seen, and indeed from what any country has ever seen. In economics the conclusions that may be drawn from observation of the events of previous times or of other countries are by no means necessarily applicable; they might, probably would, have to be largely modified when applied to our present situation. The same holds true, indeed, of all the social sciences. The phenomena which they observe, and can deal with through observation only, are ever-changing. Our task is a peculiarly laborious and perplexing one.

To return to the doctors and the contrast between them and the economists. In one direction we economists see a ray of light and comfort. Cancer, which I have compared to business depression, differs from some other diseases in that it is not one of those which set up within the body a so-called

defensive action. I am aware that the term 'defensive action' is a metaphor, and tells us nothing about what really happens; but it indicates what is known about the outcome. There are wide-spread diseases which appear in an incipient or minor stage in large numbers of persons, but more often than not are stopped or walled in, by some quasi-spontaneous resistance or reaction, before real harm has been done. Such is the case with tuberculosis and infantile paralysis. In the majority of cases, the disease takes care of itself. The doctors do not quite know how it happens, but somehow it does. Not so with cancer. That proceeds relentlessly. Neither nature nor contriving man offers any aid, any device toward mitigating it or preventing it from proceeding relentlessly to the end.

When it comes to crises, our observations indicate that the case is like that of the defence-creating diseases. Somehow or other the thing seems to cure itself. Minor crises and depressions are got over with comparative ease. Even the great and deep-reaching ones, such as we are now in the midst of, run their course, and health sets in again. We do not know quite how it happens, any more than the doctors quite know how tuberculosis is stopped or how the patient recovers when once the crisis in pneumonia has passed. Whatever be the explanation, all our observations show that in due time industry recovers from its ills, and sets out again to new conditions of health not worse than those of the earlier periods. I take it this will happen with the present depression. We are not irretrievably slipping to a fatal end.

PROGRESS AND DEPRESSIONS—AND OUR AMERICAN DOLLAR

By IRVING FISHER

IN ANSWER to the question as to why so steady a rate of progress in business should be interrupted by so sudden disasters as crashes and depressions, I would say that the main key is the accumulation of too much debt. This leads to forced liquidation which leads to currency deflation.

More than nine tenths of our money is not money, strictly so-called; that is, it is not legal tender; it is bank credit circulating in the form of checks. This mass of circulating credit rests on business loans at commercial banks. The inflation of these loans results in the inflation of check circulation; and when liquidation becomes an epidemic, it deflates the credit circulation.

There is, of course, always a certain amount of forced liquidation; but in normal times, this does not affect the general volume of credit currency, because one loan, wiped out, is replaced by another, opened up. But when the amount of credit is excessive, forced liquidation far overbalances the new loans and becomes deflation.

This deflation begins, of course, with the more reckless debtors; but, by a kind of vicious circle, it soon spreads to some of the strongest and most conservative. For, as soon as it amounts to genuine currency deflation, it deflates the prices on which *all* business, including the most conservative, depends, for solvency and for profit. In the capital account, when deflation occurs, assets dwindle, but liabilities (consisting of contract debts) refuse to budge; so that net worth is squeezed between the upper and the nether millstone, sometimes resulting in bankruptcy. In the income account, a similar process takes place. Prices, which furnish the

income, dwindle; but expenses (such as wages and interest) change but little; so that profits are squeezed.

According to his profits, does a man run his business. When the profits shrink, he curtails his out-put and his payroll, thus adding to unemployment.

A word about the actual operation of these principles in the present crisis:

In 1929 the pyramid of debts payable in American money had reached, no doubt, the highest peak in all history. Roughly, they amounted to 234 billion dollars. They included the debts of foreign governments; private foreign loans; State, local and Federal debts; mortgages; farm mortgages; other agricultural debts; corporation debts; consumers' credits; commercial bank loans; and brokers loans. Practically every category had been increasing enormously until about 1929. Brokers loans were among the last to rise, but when they started, they shot up with especial violence. Then they were the first to crumble; and (largely because they were call loans), they crumbled fastest and farthest.

A sinking price-level is really a bloating dollar. And as a consequence of a bloating dollar, we have this paradox: *the swelling dollar has swollen the real burden of debts faster than liquidation could reduce it.* In a word, there has, in most cases, been liquidation only in name. Brokers' loans are an exception, having been reduced in fact as well as in name; but farm mortgages, for instance, though nominally less by 20 per cent, are really greater by 22 per cent,—and this is but an addition to a similar growth of burden which had been afflicting the farmer for years. As for the grand total of 234 billions, nominally it is now reduced by 16 per cent, but really it is 29 per cent more.

What, then, started the over-indebtedness in the first place? There were:

1. The World War,
2. Currency Inflation,
3. Invention on a mass scale.

And all these influenced business Optimism, which so reacted as to aggravate Inflation and mass Invention.

Thus, in a depression, there are two diseases:

I. *The Debt Disease* (too much debt)
II. *The Dollar Disease* (an hypertrophied dollar)

Some day, perhaps, the debt disease may, through better statistics, be subjected to direct treatment; but, meanwhile, the cure of the Dollar disease, through stabilization, would, in itself, be enough to limit the Debt Disease; for the cure of the Dollar Disease involves the control of all forms of inflation and deflation, and such control includes credit control.

Thus could our American dollar be stabilized. The means of stabilization are at hand. They exist in the Federal Reserve System and other Federal agencies; and if, under legislative mandate, they are properly used, one of the greatest reforms in economic history will be achieved.

THE EVOLUTION OF BIOLUMINESCENCE AND ITS RELATION TO CELL RESPIRATION

By E. NEWTON HARVEY

(*Read April 21, 1932*)

LIGHT-PRODUCING organisms can be divided into two great groups, those which secrete a luminous slime or fluid to the exterior of the body, such as many worms and the ostracod crustacean, *Cypridina*, and those which produce light within the cell, such as fire-flies and luminous bacteria. Oxygen is necessary for luminescence in both groups. In addition many studies have demonstrated that an easily oxidizable substance, luciferin, and a second body, luciferase, are concerned in light production.[1] I believe the luciferase plays two rôles—one that of catalyst accelerating the oxidation, and second that of supplying molecules which can pick up the energy of oxidizing luciferin. This energy is radiated as light, when the excited molecules of luciferase return to the normal state. The mechanism might be represented as follows, the prime (′) indicating an energy-rich molecule:

$$\text{Luciferin } (LH_2) + 1/2\ O_2 \xrightarrow{\text{Luciferase}} \text{Oxyluciferin } (L') + H_2O.$$
$$\text{Oxyluciferin}' + \text{luciferase} = \text{oxyluciferin} + \text{luciferase}'$$
$$\text{Luciferase}' = \text{Luciferase} + h\nu \text{ (a quantum of light).}$$

In light production we thus have a photogen, oxygen, and an oxidative catalyst, just as in cellular oxidation of food stuffs we are concerned with the metabolites, oxygen and the respiratory catalysts. There is this difference, however, that food stuffs are oxidized to CO_2, whereas luciferin is not. All attempts to demonstrate the production of CO_2 have failed.[2]

[1] Harvey, E. N., 1927, Nat. Res. Council. Bull. No. 59, p. 50.

[2] Harvey, E. N., 1919, *Journ. Gen. Physiol.*, 2, 133.

What, then, is the relation of light production to cell respiration?

In the lowest and simplest luminous forms, the luminous bacteria, I believe the luminous mechanism is a part of the respiratory mechanism and that the development of luminosity in the animal kingdom represents a specialization of one phase of the respiratory process, namely the development of special hydrogen acceptors.

It is well known that all aerobic cells, to which the luminous cell belongs, possess three enzymes concerned in respiration: (1) a reducing catalyst, dehydrase or reductase; (2) catalase, which decomposes H_2O_2; and (3) a peroxidase which can transfer the oxygen of peroxides to oxidizable substances. According to the Wieland view the reductase is involved in the oxidation of metabolites (M) by the following scheme in which water supplies the oxygen, and a hydrogen acceptor (A) combines with the hydrogen.

$$M + H_2O + A \xrightarrow{\text{reductase}} MO + AH_2$$

The reduced acceptor (AH_2) is then oxidized by the O_2 of the blood or air, forming H_2O_2 which is prevented from accumulating in cells by catalase:

$$AH_2 + O_2 = H_2O_2 + A$$

$$H_2O_2 \xrightarrow{\text{catalase}} H_2O + 1/2\ O_2$$

On the other hand the Traube-Bach-Engler view supposes that auto-oxidizable substances (B) in cells form peroxides from the oxygen of blood or air which are then broken up by peroxidase with transfer of active oxygen to the metabolites (M), thus:

$$B + O_2 = BO_2$$

$$BO_2 + 2M \xrightarrow{\text{peroxidase}} 2MO + B$$

B is fundamentally an oxygen carrier and many Fe compounds

can play this rôle by change of valence as Warburg has shown. It is possible that both mechanisms are involved, the peroxidase transferring oxygen from H_2O_2, formed according to the Wieland mechanism. It is characteristic of both hydrogen acceptors and oxygen carriers that they can be used over and over again. In any case substances have been found in cells which may act as H_2 acceptors, of which the best known are oxidized glutathione and cytochrome.

In 1918 [1] I showed that oxidized luciferin, or oxyluciferin for short, could be reduced to luciferin again in a test tube. The methods of doing this were such as to indicate that hydrogen was added to the oxyluciferin, which can, therefore, act as a hydrogen acceptor, and I suggested that in the fire-fly luciferin was converted into oxyluciferin during the flash and the reverse change occurred in the intervals between the flashes, the same material being used over and over again, thus tending toward economy and efficiency. In luminous bacteria we may suppose there is always a definite concentration of luciferin held reduced in one region of the cell which oxidizes in another region with light production, possibly at the surfaces of granules of luciferase. In many protozoa it is observed that luminescence is associated with definite granules but bacteria are too small to determine this by direct observation. Whereas in the fire-fly we have successive oxidation and reduction, in bacteria we may have simultaneous oxidation and reduction. Models of both types of mechanism can be easily constructed in the laboratory.[2] The bacterial type is imitated by any surface continuously producing nascent hydrogen. A cathode of Pt placed in a mixture of oxyluciferin and luciferase will glow continuously just like a luminous bacterium. The nascent hydrogen produced at cathode reduces the oxyluciferin to luciferin in a zone near the metal, while in a zone just outside, oxidation of the luciferin with luminescence occurs.

In luminous bacteria we have a means of testing whether luciferin accumulates under conditions where it cannot be

[1] Harvey, E. N., 1918, *Journ. Gen. Physiol.*, 1, 133.

[2] Harvey, E. N., 1923, *Journ. Gen. Physiol.*, 5, 275.

oxidized, as would occur with hydrogen acceptors in general. In fact we can measure quantitatively in arbitrary units the amount of luciferin which is stored up under these conditions. If we keep luminous bacteria in absence of oxygen no light can be produced. If we then readmit air, their luminescence reappears and is very much brighter than previously, but falls off rapidly in a few seconds, to the original intensity.

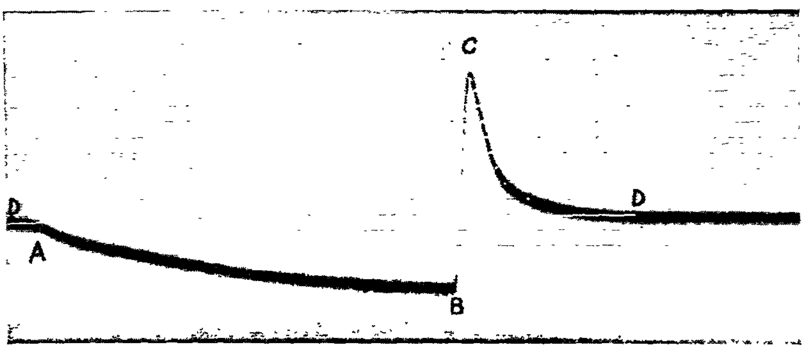


FIG. 1. Photo-cell string galvanometer record of light intensity of a suspension of luminous bacteria kept in absence of oxygen until the light begins to dim (A) and completely disappears (B), when air is again bubbled through the suspension. Note the "excess luminescence," C, and rapid return to the original intensity, D. Light intensity in arbitrary units on ordinate and time in seconds on abscissae.

Fig. 1 shows one of the records of this effect taken with a photocell, amplification, and string galvanometer combination, as described in a previous communication to the Society.[1] It will be observed that the intensity after lack of oxygen rises to twice that of the normal luminescence of the bacteria. Analysis of the decay of this excess luminescence or luminescence debt, as it may be called, shows that the decay is approximately logarithmic and consequently we may conclude that light intensity is a fair measure of the concentration of accumulated luciferin in the bacteria. The light intensity falls off in proportion to the luciferin remaining unoxidized, according to the unimolecular law, just as has been demonstrated in the case of Cypridina luciferin in solution in a test tube.[2]

[1] Harvey, E. N. and Snell, P. A., 1930, *Proc. Amer. Philos. Soc.*, **69**, 303.

[2] Amberson, W. R., 1922, *Journ. Gen. Physiol.*, **4**, 535.

The area of the excess luminescence curve tells us the total amount of excess light in arbitrary units and gives us a means of comparison with the normal rate of light production of the bacteria each second. The area of the excess luminescence curves is independent of the time the bacterial suspension has remained in absence of oxygen (provided the anaerobic conditions are not continued too long), which I interpret to mean that the accumulating luciferin quickly reaches an equilibrium. In the normal bacteria we must have a steady state, a balance between reduction and oxidation. A somewhat greater amount of excess light is produced if pure oxygen, instead of air, is bubbled through the suspension after anaerobiasis, but this relation has not appeared in all the records. In general we may say that the excess luciferin stored up under anaerobic conditions is such that it would be used in 3 to 5 seconds by the bacteria, oxidizing under normal conditions of adequate oxygen supply. By adequate oxygen supply we mean pressures of oxygen from 0.26 per cent to 100 per cent oxygen, for the light intensity is independent of oxygen pressure within these limits and only begins to diminish with oxygen pressures below 0.26 per cent.[7]

The oxygen consumption (or respiration)—oxygen pressure curve has been studied by Shoup [1] who finds that oxygen consumption is independent of oxygen pressure from 21 to 3 per cent oxygen, begins to fall off at about 3 per cent oxygen and is only 50 per cent of the normal at 0.26 per cent oxygen where the light begins to dim. Luminescence and respiration are thus partly interrelated processes. This leads me to believe that in bacteria the luminescence mechanism is part of the respiratory mechanism. We find in general that those factors such as temperature, oxygen tension and added substances like KCN, which affect luminescence intensity also affect rate of respiration in the same direction.

However, there is no direct proportionality between respiration rate and luminescence intensity in relation to the above mentioned factors, as is well seen in the case of oxygen

[1] Shoup, C. S., 1929, *Journ. Gen. Physiol.*, 13, 27.

pressure, where the respiration may be reduced 50 per cent without affecting the light intensity. KCN has an unusual interest because of its special inhibiting action on cell respiration in general.[1] A concentration of KCN (M/5000) which reduces the respiration of luminous bacteria to 5 per cent of its previous value, reduces the light intensity to only 20–25 per cent of the normal value. KCN experiments give conclusive proof that luminescence in bacteria is bound up with respiration, for KCN (even M/250) does not influence the luminescence of a mixture of Cypridina luciferin and luciferase which can be obtained *apart* from actively respiring living cells.

Therefore, we are led to the following view of the evolution of luminescences. In the simplest organisms, the bacteria and the fungi, light production evolved in connection with the respiratory mechanism by the development of one of the hydrogen acceptors whose oxidation gives sufficient energy to excite a compound similar to luciferase, possibly some special protein within the bacterial cell. Chemiluminescence[1] studies have shown that fluorescent compounds, *i.e.* substances which can be excited to luminescence by the energy of radiation, are also most likely to exhibit chemiluminescence. They are excited by the energy of a chemical reaction. Practically all proteins are fluorescent and all luminous cells are somewhat fluorescent. In addition, many luminous animals have unusually bright fluorescent compounds in their luminous organs.[2] It is not, therefore, surprising, it is likely that an unusually bright "photophore" group in a protein should be seized upon and developed during the evolutionary process to the chemiluminescent substance, luciferase. Since the bacteria and fungi produce a steady luminescence which is unaffected by stimulation, this luminescence may be regarded merely as an accompaniment of the hydrogen acceptor mechanism; hence fortuitous and of no special use to the organism.

[1] Harvey, E. N., 1925, *Journ. Gen. Physiol.*, 8, 89.
[2] Harvey, E. N., 1926, *Amer. J. Physiol.*, 77, 555.

The next step is the development of a mechanism for controlling the luminescence, for protozoa (dinoflagellates, cystoflagellates and radiolaria) have developed within the cells a means of glowing only on stimulation, which is comparable to the stimulating mechanism of a muscle or nerve cell.[1] The mechanism of luminescence on stimulation, whether due to sudden admission of oxygen to the cell or bringing together of luminous materials or change of conditions at a membrane cannot be definitely stated, but I hope to deal with this problem at a later date.

Practically all higher forms also luminesce only on stimulation and various means have been devised to bring this about. In multicellular animals we find developed, special glands for secreting luminous material or special organs of luminescence with accessory structures; shutters, reflectors, lenses, pigment screens and color screens, the whole forming a lantern. Here we may see a use for luminescence, warning or frightening predaceous forms, luring food, illumination or recognition signals in the bringing together of the sexes.

There has never been any great evolution in the direction of an entirely luminous group. Perhaps the cœlenterates most closely approach this, for luminescence is more widespread there than in any other phylum. Generally, luminescence has appeared sporadically in the living world, with a few luminous species scattered here and there among structurally very close non-luminous relatives. This again means that luminescence can be readily developed in the course of evolution by some slight change in a mechanism *already existing* within all cells. I believe this mechanism is the respiratory one and that luminescence has resulted from the transformation of some of the hydrogen acceptors of the cell, together with the development of proteins with very actively fluorescent groups which are excited to luminescence by the energy of the oxidative dehydrogenation.

[1] Harvey, E. B., 1917, Carneg. Inst. Wash. Pub. No. 251, p. 235.

THE BASAL HEAT PRODUCTION OF ELDERLY WOMEN

By FRANCIS G. BENEDICT AND MARY HENDERSON MEYER

(*Read April 21, 1932*)

In the last three decades evidence with regard to the basal metabolism of humans has accumulated rapidly, in direct proportion to the facility with which subjects for measurement have been secured. Thus, for the college age and for the age of childhood a large number of observations have been obtained, both in the United States and in Europe. For middle age, data have been only slowly accumulated. A special effort was made at the Nutrition Laboratory to secure measurements with women between 50 and 60 years of age, and these have been already published.[1] Aub and Du Bois have measured the basal metabolism of old men,[2] but there is little information in the literature concerning the metabolism of women 70 years of age and over. Andral and Gavarret,[3] in 1843, measured the carbon-dioxide production of women 19 to 82 years of age and, although their observations can not be accepted as basal, they found a decrease in the gaseous exchange with age. Gréhant and Quinquaud,[4] in 1882, concluded from studies on two women, 61 and 87 years old, respectively, that the carbon-dioxide production also decreases with age. Magnus-Levy and Falk,[5] in 1899, published a long series of observations on humans from early youth to 86 years and including both elderly men and women. They concluded that the gaseous exchange decreases in old age, and that per kilogram of body weight it is lower than

[1] Harris, J. A., and F. G. Benedict, Carnegie Inst. Wash. Pub. No. 279, 1919.

[2] Aub, J. C., and E. F. Du Bois, *Arch. Intern. Med.*, 1917, *19*, p. 831.

[3] Andral, G., and J. Gavarret, *Ann. de Chim. et de Phys.*, 1843, 3d ser., *8*, p. 129.

[4] Gréhant and Quinquaud, *Journ. de l'Anat.*, 1882, *18*, p. 469.

[5] Magnus-Levy, A., and E. Falk, *Arch. f. Anat. u. Physiol.*, Physiol. Abt., Suppbd., 1899, p. 314.

that of an individual of the same weight in middle life. Legrand,[1] in 1926, reported observations on 9 women ranging in age from 66 to 82 years. The heat production per square meter of body surface per hour varied from 33.6 to 39.5 calories, averaging 35.5 calories. Aub and Du Bois [2] suggest for women between 70 and 80 years a value of 33.0 calories per square meter of body surface per hour. All of Legrand's subjects had a metabolism higher than this, which is explained by the author on the ground that perhaps they were emotional and not strictly post-absorptive.

Most of the observations on elderly people have been secured with "hospital normals," usually hospital patients with minor ailments. Irrespective of the practical value of such observations in the hospital, the use of these measurements in comparative studies in normal physiology is questionable. An effort was therefore made at the Nutrition Laboratory to measure the basal metabolism of a number of normal elderly women (not hospital normals), chiefly in the decade between 70 and 80 years. Twenty-three women were finally measured, one of 66 years, one of 68 years, thirteen between 70 and 80 years, and eight between 81 and 86 years.

Plan of Research

As pointed out by Harris and Benedict in discussing the metabolism of old age,[3] the selection of material is important. What are to be the criteria for normality with elderly people? Mere existence to the age of 80 years is of itself indication of unusual vitality and inborn physical vigor. Bedridden hospital patients are obviously out of consideration. A complete physical examination with perfect score is an ideal not to be realized. We therefore had to compromise and be satisfied with the estimate that our subjects were "presumably in good health." Through the kindness of Dr. Elliott P.

[1] Legrand, R., *Revue française d'Endocrinologie*, 1926, *4*, p. 199; ibid., *Le Système Endocrino-Sympathique du Vieillard*, Lille, 1926, p. 141.

[2] Aub, J. C., and E. F. Du Bois, *Arch. Intern. Med.*, 1917, *19*, p. 831.

[3] Harris, J. A., and F. G. Benedict, Carnegie Inst. Wash. Pub. No. 279, 1919, p. 107.

Joslin, we were able to present our problem to the Massachusetts Home in Boston. There the enthusiastic coöperation of the hostess, Mrs. Ruth E. Lindon, made it possible for us to establish friendly relations with a large proportion of the guests at the Home. None of these ladies was bedridden. All went to the common dining-room for their meals. Most of them took care of their own rooms, and not a few rendered service in the general care of the Home itself. If allowances are made for the frailties of extreme age, all could be classified as women "presumably in good health."

The subjects were measured in bed, after a night's repose, having emptied the bladder at 6.30 A.M. The metabolism measurements began at about 7 A.M. or 7.30 A.M. and continued until 3 or 4 well-agreeing periods were secured. The observations were repeated on a second and a third day, and occasionally a fourth day, at not too great intervals. Along with the observations of the oxygen consumption and the pulse rate, the usual records were made regarding the age, body weight, and height. The blood pressure (systolic and diastolic) of each subject was kindly recorded by Dr. Lyman H. Hoyt, physician in charge at the Massachusetts Home. Independent estimates of the physical vigor of these women were made by the physician, the hostess, and the operator (M. H. M.), from which was derived an average rating of the vigor of each subject.

Apparatus Employed

People of advanced years, no matter how willingly they may coöperate, can not be expected to have such zeal for physiological knowledge that they can adapt themselves readily to the rather uncomfortable mouthpiece and nose-clip employed with the usual metabolism apparatus. Problems of precisely this type motivated the development of a helmet [1] respiration appliance that does not necessitate the discomfort of the ordinary forms of breathing appliances, either the nosepieces, the mouthpiece, or the face mask. The helmet itself

[1] Benedict, F. G., *New Eng. Journ. of Med.*, 1930, *203*, p. 150.

is a pail-shaped vessel, provided with a small window for the free vision of the subject. (See Fig. 1.) This pail is inverted over the head. Air-tight closure between the helmet and the neck is secured by a thin rubber collar, which fits closely but comfortably about the neck. The helmet connects with

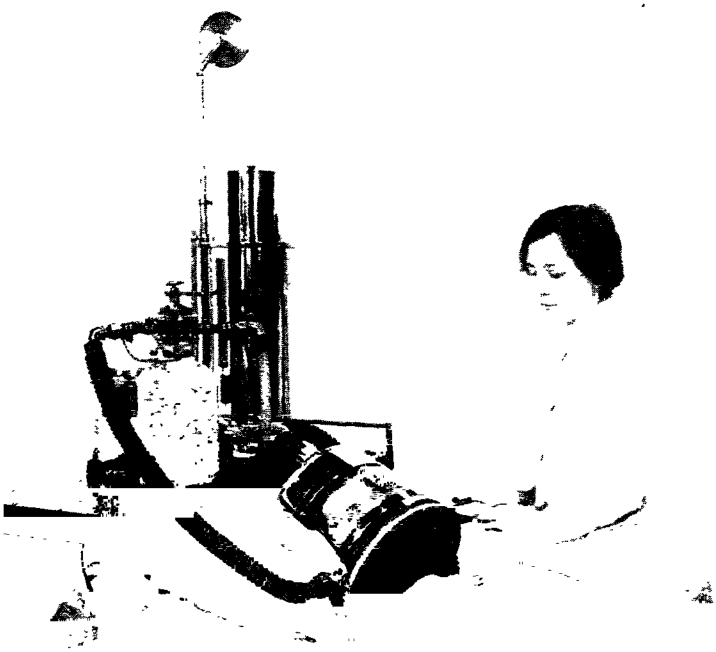


FIG. 1. THE HELMET RESPIRATION APPARATUS

Air-tight closure of the helmet about the neck of the subject is obtained by means of a thin rubber diaphragm. The helmet is connected with a blower, which withdraws the air from the helmet and passes it through a glass bottle containing a carbon-dioxide absorbent. From this bottle the air, deprived of carbon dioxide, is returned to the top of the helmet. A spirometer, containing oxygen-enriched air, is connected directly with the helmet by an independent tube. The movements of the spirometer bell and the fall in level of the bell, caused by the respiration of the subject, are recorded graphically on the kymograph.

a closed, ventilated circuit of oxygen-enriched air. A small, noiseless rotary blower withdraws the air from the helmet near the bottom, passes it through an absorbent for

carbon dioxide, and returns it to the top of the helmet. A delicately counterpoised spirometer is connected directly with the helmet, thus insuring most rapid and unhampered adjustment to changes in pressure. With each respiration the spirometer bell rises and falls, and as the oxygen is used by the subject out of the closed system, there is a continuous fall in the level of the spirometer bell. This fall in level, along with the regular respiratory movements, is registered on a kymograph drum. From the graphic tracing and the records of temperature, pressure, and time, the oxygen consumed per minute (at 0° C., dry, and 760 mm.) is calculated.

The application of the helmet to the head is simple and rapid and causes no discomfort. A carbon-dioxide absorbent is used [1] that removes simultaneously not a little moisture from the air so that the air, as it enters the helmet and is deflected down over the forehead and face, gives a cool sensation to the skin. The women were very coöperative. Subjective impressions were sought and recorded at the close of the experiments, but in general the women had no comments to make other than that they were surprisingly comfortable during the tests. Indeed, they found the headpiece so comfortable that three or four consecutive periods could be carried out without removing the helmet or disturbing the subject in any way. This feature is of great advantage, making it possible not only to secure several consecutive periods but to note any tendency for the metabolism to decrease as the number of periods are extended. The analysis of numerous tests with the helmet respiration apparatus on hospital patients and normal individuals has shown, however, that after a few moments necessary to secure equilibrium, the metabolism remains singularly uniform from period to period.

With our subjects in one or two instances the metabolism was somewhat higher on the first day of measurement than on subsequent days. Usually the results of the second and third days agreed well. In the final analysis of our data, with but few exceptions, the measurements obtained on all the

[1] Shell caustic furnished by Uehling Instrument Co., Paterson, New Jersey.

different days with any one subject have been averaged. Our deductions are therefore based upon average values obtained in from 6 to 14 periods on from 2 to 4 days.

Discussion of Results

The physical characteristics of our subjects are indicated in order of increasing ages in table 1. The heights as recorded in this table are undoubtedly somewhat lower in some instances than was really the case. With some elderly people an erect posture can not be secured, due to the settling of the cartilage and the tendency to a stooping posture with advanced years. The estimates of the bodily vigor are indicated by the letters A to E. Those women considered unusually vigorous for their age have been designated by A+, those in normal vigor by A, those with correspondingly less vigor by B and C, and the one individual with the least vigor by E. With a group of 23 individuals considerable differences in apparent vitality and activity are to be expected. Thus, according to the personal impressions of those closely associated with these women (as indicated by the estimates of vigor given in the seventh column of table 1) two had unusual vitality for their age, seven were in normal vigor, thirteen in somewhat less vigor, and only one might be characterized as feeble. They obviously could not be compared in activity with a young, vigorous matron, but in the analysis of the results obtained, we may consider that we were dealing with women in normal health for their advanced age.

The results of our basal metabolism measurements on elderly women are summarized in Table 2. The heat production has been calculated from the measured oxygen consumption, on the assumption that each liter of oxygen consumed under basal conditions has a caloric value of 4.825 calories (at an assumed respiratory quotient of 0.82). For purposes of testing the present-day accepted methods for metabolism prediction with this series of normal material, the actual heat production of each subject is compared with the heat production predicted for a woman of a similar age, weight, and height,

TABLE 1

PHYSICAL CHARACTERISTICS OF SUBJECTS

Subject No.	Age	Body Weight (Without Clothes)	Height	Blood pressure		Vigor
				Systolic	Diastolic	
	yrs.	kg.	cm.	mm.	mm.	
I	66	50.3	159	154	84	A
II	68	70.9	154	194	102	C
III	70	72.1	157	178	110	B
IV	70	52.4	150	230	120	C
V	71	72.0	159	170	90	C
VI	71	63.7	153	160	100	B
VII	71	66.6	168	182	120	B
VIII	71	53.0	156	210	110	A
IX	73	64.0	157	170	85	C
X	74	63.0	149	194	100	C
XI	74	44.7	159	170	90	A
XII	76	49.4	152	182	82	B
XIII	77	31.8	138	172	84	A+
XIV	78	41.6	145	150	100	C
XV	79	69.2	151	160	100	C
XVI	81	40.6	152	180	130	A
XVII	81	66.9	147	160	80	A+
XVIII	84	50.2	146	170	90	A
XIX	84	43.9	158	200	70	B
XX	84	44.5	144	150	90	C
XXI	84	45.4	151	180	120	A
XXII	84	63.3	147	164	100	E
XXIII	86	54.0	150	142	64	A

according to the standards of Harris and Benedict,[1] Aub and Du Bois,[2] and Dreyer.[3] Strictly speaking, the deviations should have been computed upon the basis that the new material was standard and the predictions were being tested. To follow the usage employed in the earlier comparisons of the measured metabolism of younger people with the standards, we have here compared the measured metabolism with the standard, and the percentage deviations of the actually measured metabolism from the predicted metabolism by these three standards are recorded in the last three columns of Table 2. Since the Aub and Du Bois standards for women do not

[1] Harris, J. A., and F. G. Benedict, Carnegie Inst. Wash. Pub. No. 279, 1919.

[2] Aub, J. C., and E. F. Du Bois, *Arch. Intern. Med.*, 1917, *19*, p. 831.

[3] Dreyer, G., *Lancet*, 1920, Part 2, p. 290.

extend beyond 80 years, it has been necessary to make the predictions above this age by extrapolation from the prediction values for ages below 80 years.

TABLE 2

BASAL METABOLISM OF ELDERLY WOMEN

Subject No.	Age	Observations		Pulse rate	O_2 per min.	Heat produced per 24 hours			Deviations of measured from predicted heat		
		Days	Periods			Total	Per kg.	Per sq m.[1]	Harris-Benedict	Aub and Du Bois	Dreyer
	yrs.				c.c.	cal.	cal.	cal.	p ct.	p.ct.	p.ct.
I	66	3	11	63	134	931	18.5	621	−16.9	−24.0	−18.3
II	68	3	10	72	196	1359	19.2	800	+ 4.6	− 2.0	+ 1.0
III	70	3	7	75	202	1401	19.4	810	+ 7.1	+ 2.2	+ 3.6
IV	70	4	8	80	160	1112	21.2	762	+ 0.5	− 3.9	− 3.6
V	71	3	7	80	216	1501	20.8	858	+14.9	+ 8.3	+11.2
VI	71	3	12	72	165	1149	18.0	714	− 5.5	− 9.9	− 9.5
VII	71	3	8	69	190	1323	19.9	752	+ 4.1	− 5.1	+ 2.0
VIII	71	4	10	71	158	1096	20.7	726	− 2.1	− 8.4	− 5.3
IX	73	4	14	58	190	1318	20.6	799	+ 8.4	+ 0.9	+ 4.1
X	74	2	6	76	162	1122	17.8	715	− 5.5	− 9.8	−10.6
XI	74	3	8	65	135	936	21.0	654	− 9.2	−17.4	−11.5
XII	76	4	12	68	165	1148	23.3	803	+ 8.9	+ 1.4	+ 3.7
XIII	77	3	12	60	115	799	25.1	713	− 6.4	− 9.9	− 9.9
XIV	78	3	7	65	140	973	23.4	749	+ 1.8	− 5.5	− 3.9
XV	79	3	7	70	151	1049	15.2	636	−14.5	−19.7	−19.5
XVI	81	3	10	72	138	961	23.7	723	+ 1.6	− 5.9	− 3.4
XVII	81	3	11	56	149	1035	15.5	647	−12.8	−15.7	−19.0
XVIII	84	3	8	64	146	1015	20.2	720	+ 0.3	− 6.3	− 7.9
XIX	84	3	11	74	150	1045	23.8	741	+ 7.2	− 3.5	+ 1.4
XX	84	2	8	74	154	1070	24.0	811	+12.2	+ 5.6	+ 3.2
XXI	84	2	6	67	140	973	21.4	705	− 0.3	− 8.2	− 7.1
XXII	84	3	10	73	139	966	15.2	619	−15.3	−19.4	−21.9
XXIII	86	3	11	78	148	1026	19.0	693	− 2.0	− 9.7	− 9.9
Avg.									− 0.8	− 7.2	− 5.7

[1] Body surface assumed from body weight and height according to the Du Bois body-surface chart (Du Bois, D., and E. F. Du Bois, *Arch. Intern. Med.*, 1916, *17*, p. 863).

Total Heat Production Referred to Age and Body Weight.—The main object of our study was to note what effect advancing age has upon the metabolism. Hence every effort was made to accentuate the age factor, in order to determine whether the metabolism in old age has any particular charac-

teristic level. Among the women measured we had to deal not solely with the factor of age but also with the factors of body weight and height, for these women ranged in weight from 32 to 72 kg. and in height from 138 to 168 cm. The age factor itself can be studied, first, by comparing the total heat production of these women with their age. Such a comparison is shown in Fig. 2, in which the *total heat production*

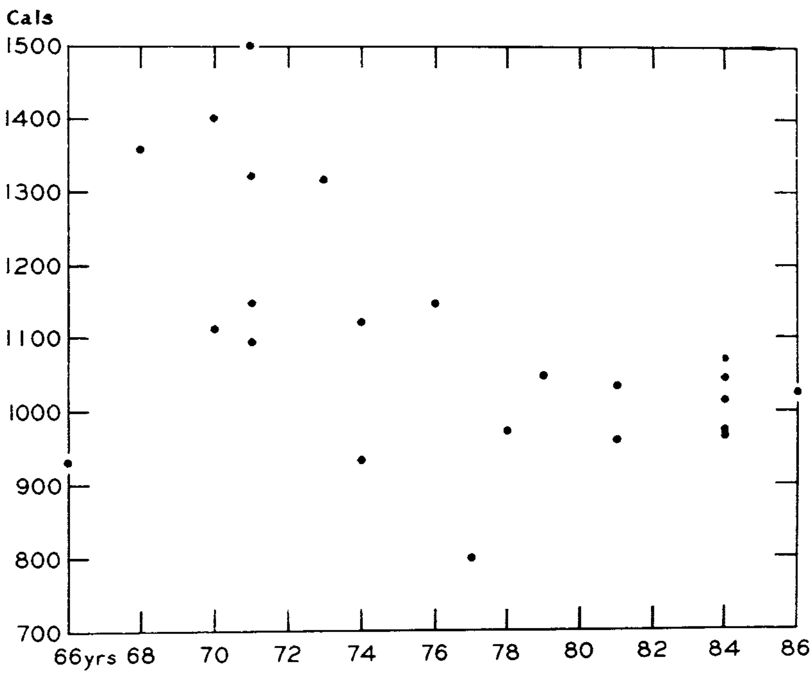


FIG. 2. TOTAL HEAT PRODUCTION PER 24 HOURS REFERRED TO AGE.

per 24 hours has been plotted with reference to the age of each subject, without regard to weight or height. As seen from this chart, the total heat production ranged from 800 to 1500 calories. It is clear that no curve can be drawn through the plotted points to indicate the trend of the total metabolism with increasing age. One fact is brought out by this chart, however, namely, that all the women 78 years old or over, specifically 10 in number, have a total metabolism strikingly

close to 1000 calories per day. If in the entire group of 23 women we except the one woman having a total metabolism of 800 calories and the 5 women having a total metabolism of over 1300 calories, there are 17 women who have a total heat production not far, on the average, from 1035 calories. Comparison of the total metabolism with the body weight (see Tables 1 and 2) shows that there are 10 women 78 years of age and older who have a total heat production ranging only from 961 to 1070 calories, although their body weights range from 41 to 69 kg. This uniformity in the total metabolism irrespective of body weight reminds one of the fact that young girls (Girl Scouts) from 12 to 18 years of age have been found to have a basal heat production of about 1250 calories per 24 hours, irrespective of weight, height, and age.[1] It may not be said that all women 78 years old and over will have a *total 24-hour heat production* averaging about 1000 calories, for one of our subjects (XIII) 77 years of age and weighing but 32 kg. had a total heat production of only 799 calories. This is the one extremely low value in the series. On the other hand, a number of women under 78 years likewise had a total heat production of not far from 1000 calories. It does seem more than a coincidence that all the women of 78 years or older had a total metabolism at this level. From this standpoint alone the clinician could state definitely that a normal woman over 78 years of age, practically irrespective of body weight (unless very small, as subject XIII, weight 32 kg.), would have a total 24-hour basal heat production of not far from 1000 calories. This must not be confused, however, with the much discussed value of 1000 calories per square meter of body surface.

Heat Production per Kilogram of Body Weight Referred to Age.—To equalize the differences in weights of our subjects, the heat production was computed per kilogram of body weight and the values were plotted with reference to age. The scatter of the plotted points on this chart (not reproduced

[1] Benedict, F. G., and M. F. Hendry, *Boston Med. and Surg. Journ.*, 1921, *184*, pp. 217, 257, 282, 297, and 329; Benedict, F. G., *Boston Med. and Surg. Journ.*, 1923, *188*, p. 127; Benedict, F. G., *Proc. Am. Philosophical Society*, 1924, *63*, p. 25.

here) was great and indicated no regularity in the heat production per unit of body weight as associated with age.

Heat Production per Square Meter of Body Surface Referred to Age.—In the comparison of different subjects of considerably different weights, the calculation of the heat production per kilogram of body weight is always supplemented by the calculation upon the so-called "surface area" basis, really a relationship corresponding to the two-thirds power of the body weight. In Fig. 3 we have plotted the values for the

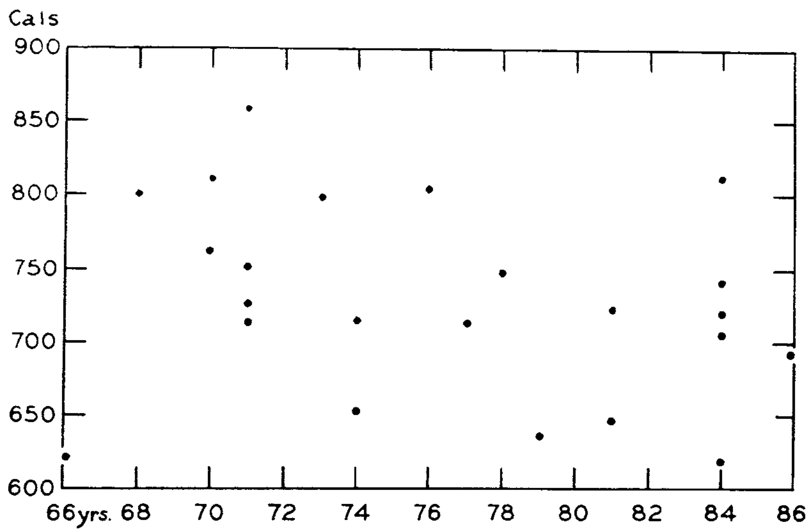


FIG. 3. BASAL HEAT PRODUCTION PER SQUARE METER OF BODY SURFACE PER 24 HOURS REFERRED TO AGE.

heat production per square meter of body surface referred to age, with the object of noting whether on this basis the older women have a different heat production from that of the less aged. There is a wide scatter in the plotted points. On the average, the metabolism per unit of surface area is 729 calories, but the values range from 619 to 858 calories. Thus even with these "presumably normal" individuals there is a variability in metabolism of 38 per cent, on the basis of the heat production per square meter of surface area. If it were permissible to draw a line through the plotted points (which has

not been attempted) to indicate the general trend of the metabolism per unit of surface area with increasing age, such a line would slope downward somewhat. The general tendency therefore is for a lower heat production per square meter of surface area with advancing age, even beyond the age of 70 years. It is impossible, however, to think of predicting, by means of Fig. 3 or by means of any correlations established from it, the heat production of elderly women per square meter of surface area from age alone, owing to the wide distribution of the values at each age. Thus, of these 23 women there are five who have a very low metabolism per unit of body surface, namely, 621, 654, 636, 647, and 619 calories at 66, 74, 79, 81, and 84 years, respectively. These values by themselves suggest the possibility of an extremely low metabolism with elderly people, but in the same age range there are 7 women whose metabolism would average not far from 800 calories per square meter of body surface. This level is but a little below that found by Harris and Benedict, on the average, with a group of 103 women, namely 850 calories.[1] Of these 103 women, however, the large majority were under 50 years of age. Those between 50 and 60 years had a metabolism averaging 760 calories. The average for our entire group of 23 women between 66 and 86 years of age is 729 calories. These averages of themselves suggest that in general there is a lower metabolism per unit of surface area with advancing age. This lower metabolism of these elderly women can not be considered as indicative that our subjects were abnormal, for even among the 5 women showing the unusually low values of 650 calories per square meter of body surface or less, the estimated vigor was A+, A, A, C, and E, that is, only one woman was what might be termed feeble.

Heat Production per Kilogram of Body Weight Referred to Weight.—In an effort to find some method of comparison that would indicate a greater uniformity in the metabolism of these elderly women than was noted in the comparisons just discussed, we prepared a number of different charts in which the

[1] Harris, J. A., and F. G. Benedict, Carnegie Inst. Wash. Pub. No. 279, 1919.

metabolism was referred to various other factors that might possibly play a rôle in the metabolism, such as the height, the computed sitting height, and the pelidisi.[1] None of these comparisons was especially significant. With these women our chief interest is in the age factor, but since there was a considerable difference in the body weights, we should likewise note whether there is an effect of body weight itself. In Fig. 4, therefore, the 24-hour heat production per kilogram of body weight has been referred to body weight. Here it is apparent that, on the whole, even at the advanced ages of 70 to 86 years (which is the age range represented by these data) the metabolism per unit of body weight is larger, the lighter the individual. Among the women of heavier weights, 63 kg. or more, there is a noticeable scatter of the plotted points. The three lowest values in this weight group are for women 79, 81, and 84 years of age. The higher values are for women between 68 and 74 years of age. This comparison within this particular weight range would, of itself, speak for a lower metabolism per unit of weight with the older women, that is, it would suggest strongly an age effect. Not enough individuals were measured in the lighter weight range for one to determine whether this is a general rule. It would appear, however, as if the lower values are for women 77 years old or over. Yet there are at least four women 78 years of age and above in the weight group from 40 to 44 kg., who have a definitely high metabolism.

Of the basal metabolism data heretofore published on elderly women, only the values reported by Magnus-Levy and Falk [2] lend themselves for comparison with our results. These have been plotted as crosses in Fig. 4. All but one of the five crosses thus plotted agree reasonably well with our data. Indeed, if one were to draw a curve through the Magnus-Levy data to indicate the general trend of the metabolism, such a curve would not be materially different from any curve that

[1] Pirquet, C., *An Outline of the Pirquet System of Nutrition*, Philadelphia and London, 1922, pp. 11–17.

[2] Magnus-Levy, A., and E. Falk, *Arch. f. Anat. u. Physiol.*, Physiol. Abt., Suppb., 1899, p. 314.

might be drawn through our own data. This comparison illustrates the extraordinary accuracy and breadth of view shown by Magnus-Levy in his marvelous studies, now over 30 years old.

In order to compare the metabolism of our elderly subjects

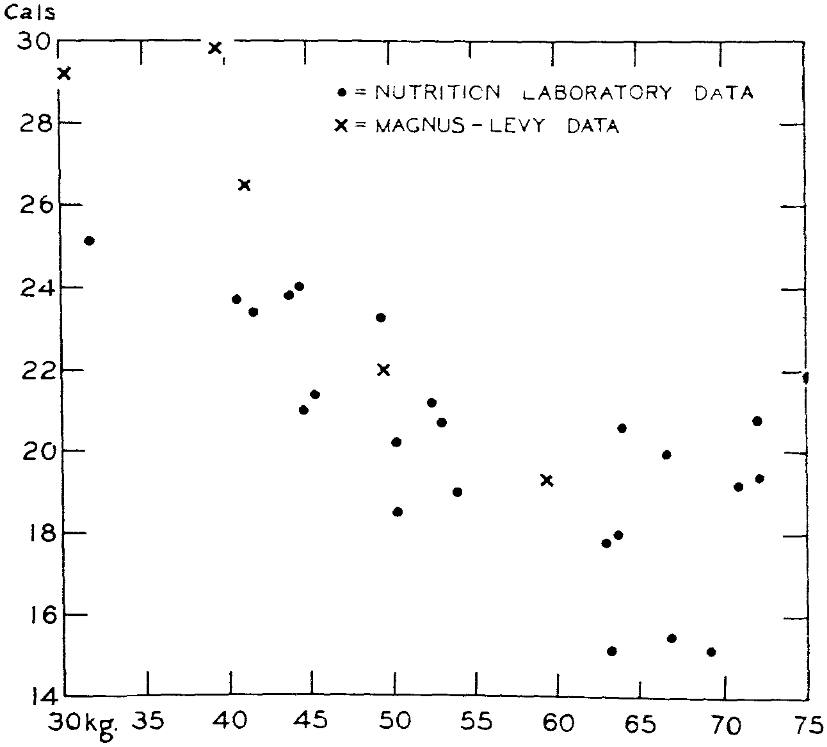


FIG. 4. BASAL HEAT PRODUCTION PER KILOGRAM OF BODY WEIGHT PER 24 HOURS REFERRED TO WEIGHT.

The three lower points at about 15 calories, between 63 and 72 kg., are for women from 79 to 84 years of age. The higher points in the same weight range are for women between 68 and 74 years of age.

with the metabolism of younger women, we have reproduced in Fig. 5 a smoothed curve, showing the average trend of the heat production per kilogram of body weight referred to weight of women. On this chart we have plotted as small dots our data obtained with elderly women of 66 to 86 years.

The curve for women represents ages up to and including 60 years, with the larger proportion under 50 years of age. This comparison shows that even at the same body weights elderly women have a definitely lower metabolism per unit of weight than do younger women. Although no curve has been drawn through the points representing elderly women in Fig. 5, it can be readily seen that if such a curve were drawn,

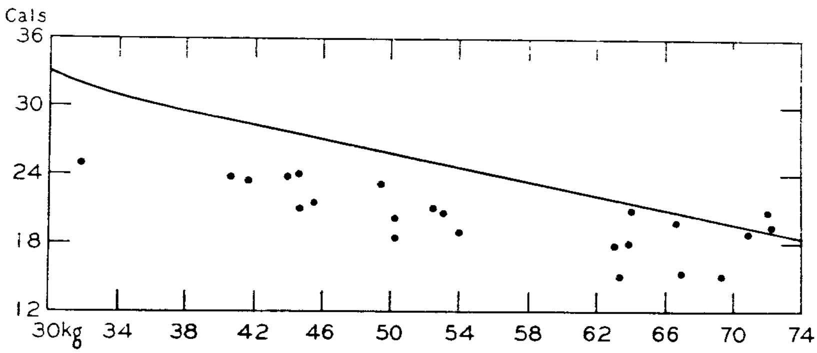


FIG. 5. BASAL HEAT PRODUCTION OF WOMEN PER KILOGRAM OF BODY WEIGHT PER 24 HOURS REFERRED TO WEIGHT.

The smoothed curve for women represents all ages up to 60 years. The small dots represent the data secured with women between 66 and 86 years of age.

it would lie at a level about 15 per cent lower than that for the younger women. Hence it may be considered that the age effect with these elderly women results in a decrease in metabolism of approximately 15 per cent.

Relationship between Metabolism and Physical Characteristics.—Examination of the heat values recorded in Table 2 shows wide differences in the metabolism of the different subjects, whether the data are calculated as total heat production, heat production per unit of weight, or heat production per unit of body surface. Since these heat values represent in every instance averages of observations obtained on from 2 to 4 days and not a chance observation on a single day, when unusual excitement might have prevailed, one wonders whether there is anything in the physical characteristics of these women to account for the wide differences

in their metabolism. On the basis of heat production per unit of surface area, subjects V, XX, and III have the highest metabolism and subjects I, XI, XV, XVII, and XXII the lowest. Except for subject I, who was 66 years old, there are no marked differences in the ages of these subjects. The pulse rates of the 3 women having the highest metabolism were 80, 74, and 75, respectively, and the systolic blood pressures 170, 150, and 178 mm. With the five subjects having the lowest metabolism the pulse rates were 63, 65, 70, 56, and 73. Here perhaps there is a tendency toward a lower heart rate. The relationship between pulse rate and metabolism has frequently been commented on from the Nutrition Laboratory, but invariably emphasis has been laid upon the differences in pulse rate in the same individual. Here the pulse rate is considered in an entirely different sense, for there is a strong suggestion that in this group of individuals those with the highest pulse rates have a somewhat higher metabolism than those with the lower pulse rates. The systolic blood pressures were 154, 170, 160, 160, and 164 mm., that is, among the lower rather than the higher blood pressures. The vigor was estimated as C, C, and B for subjects V, XX, and III, and as A, A, C, A+, and E for subjects I, XI, XV, XVII, and XXII. In other words, the physical vigor was in general notably greater with those having the lower metabolism. This is not invariably the case, however, as the comparison between subjects XVII and XXII will show. Both were of approximately the same age and weight, the former had a vigor of A+ and the latter of E, and each had essentially the same heat production. Undoubtedly the wide differences shown in the extremes in the heat production of our subjects are indicative of real individuality in metabolism, an individuality which with the 5 subjects having the lowest metabolism per unit of body surface may perhaps be characterized as a tendency toward a lower heart rate.

The extremes in metabolism may likewise be considered from the standpoint of heat production per kilogram of body weight referred to weight. In the group of heavier weight

women, between 63 and 72 kg. (where it is evident from our analysis of Fig. 4 that there is a definite age effect), the systolic blood pressure of the oldest women, that is, those with the lowest metabolism, was somewhat lower than that of the women around 70 years of age, having a higher metabolism. There was relatively little difference, however, in the diastolic blood pressure within this weight range, and hence the pulse pressure was slightly higher with the higher metabolism in this weight group. A relationship between the pulse pressure and the metabolism can not be said to be established with the women of lighter weights.

The estimates of vigor of these women likewise show no correlation with the metabolism per kilogram of body weight and the weight. Even in the weight group especially discussed, that is, between 63 and 72 kg., the state of vigor of those approximately 70 years of age was but little, if at all, better than that of the three women from 79 to 84 years of age. All through the data one finds divergent instances where women with a high rating of vigor have a low metabolism, and *vice versa*. Indeed, if one were to disregard the weight group above 63 kg., one could infer that the better the rating of vigor, the lower the metabolism per kilogram of body weight referred to weight.

This seeming lack of correlation between vigor and metabolism might perhaps be explained in large part when one compares the vigor with the body weight. Thus, the average body weight of those individuals estimated to have a vigor of A was 48.5 kg., of those having a vigor of B it was 59.1 kg., and of those having a vigor of C it was 59.7 kg. In other words, the most "vigorous" were those having the lowest body weights, and it is well known that a light-weight individual is usually much more active and spry than a heavy-weight individual. Against this explanation that the greater vigor may be attributable to the lighter body weight are the results of the observations, in his 89th year, of Dr. W. W. Keen, discussed in an earlier report.[1] His unusually high

[1] Benedict, F. G., *Am. Journ. Physiol.*, 1928, *85*, p. 614.

metabolism was ascribed to his extraordinary vigor and activity, in spite of the fact that he was definitely overweight for his height.

Comparison of Existing Prediction Standards with the Actually Measured Metabolism of Elderly Women

From the analysis of our data thus far we have seen that the probable basal metabolism of elderly women may be predicted fairly acurately from two standpoints. Thus, with women 78 years old and over it is evident that the total 24-hour heat production is close to 1000 calories, irrespective of body weight. The relationship between the metabolism per unit of body weight and the weight also offers a means of prediction, since on this basis it is evident that the metabolism will be greater with the lighter weight individuals and, within the same weight range, lower with the older women. At the time when normal metabolism standards for humans were developed, adequate material was not available for analyzing statistically the metabolism of elderly people, particularly at the more advanced ages. So far as elderly women are concerned, therefore, the three existing prediction standards (Harris-Benedict, Aub and Du Bois, and Dreyer) have been of little practical value. The observations made on our group of 23 subjects give the first basic knowledge of the metabolism of normal elderly women obtained by modern methods. Hence it is of interest to note how closely the known metabolism of these women can be predicted by the present-day standards, and thus test the prediction methods by experimentally established normal data.

Although, strictly speaking, the prediction standards should be compared with the measured normal metabolism of this group, we have followed the usual custom and have compared the measured metabolism with the prediction standards. The percentage deviations of the measured metabolism from the metabolism predicted by each of the three standards, as recorded in Table 2, have been plotted with reference to

age in Fig. 6. In this chart the deviations from the Harris-Benedict standard are indicated by hollow circles, those from the Aub and Du Bois standard by crosses, and those from the Dreyer standard by solid dots. In many instances there are at any given age one each of these symbols for one and the same individual. In such instances one can readily see that almost invariably the hollow circle (Harris-Benedict) is uppermost, the dot (Dreyer) next, and the cross (Aub and Du Bois) lowest. On the whole the majority of the values are on the

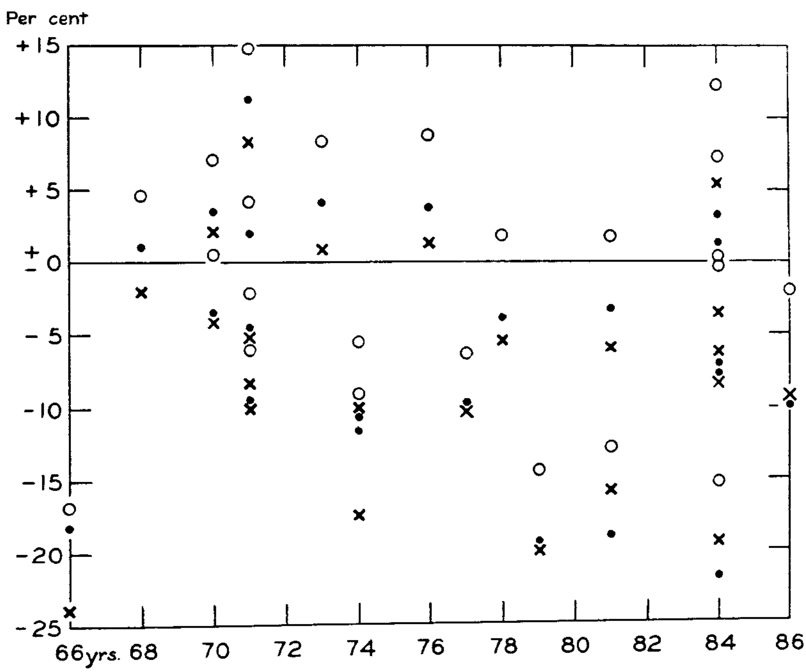


FIG. 6. PERCENTAGE DEVIATION OF MEASURED FROM PREDICTED METABOLISM REFERRED TO AGE.

The deviations from the Harris-Benedict predictions are indicated by hollow circles, those from the Aub and Du Bois predictions by crosses, and those from the Dreyer predictions by solid dots.

minus side. The hollow circles are distributed almost uniformly above and below the zero line, the dots are for the most part below, and the crosses are still farther below, only five

crosses being above the line and two of these representing a deviation of less than +2 per cent.

At first sight it might be inferred that the Harris-Benedict predictions approach more nearly the actual measured metabolism than do the other predictions. It is impossible, however, from general inspection of the percentage deviations recorded in Table 2 or from the scatter of the plotted data in Fig. 6 to determine which prediction method gives results in closest agreement with the measured metabolism. If the percentage deviations are averaged (with regard to sign), it is seen that the deviation is −0.8 per cent by the Harris-Benedict method, −7.2 per cent by the Aub and Du Bois method, and −5.7 per cent by the Dreyer method. Superficially this would indicate that the Harris-Benedict standard is the most accurate for predicting the metabolism of a group of elderly women. It is possible, however, that this apparently close agreement is false, that there is more variability in the percentage deviations by this method than by the other two methods, but that large plus deviations compensate for the large minus deviations so that the final average is close to ±0 per cent. From inspection of the data in Table 2 it is seen that the range in the percentage values is slightly less by the Harris-Benedict standard than by the other two standards. Calculations of the standard deviations in these cases show that the variability is essentially the same by all three methods. It may be concluded, therefore, that the Harris-Benedict formula is the best for predicting the probable metabolism of a *group* of elderly women. The fact must not be overlooked, however, that individuals will be found whose metabolism will vary greatly from the metabolism predicted by this method, as well as by any other method. From the scatter of the plotted data in Fig. 6, for example, it would appear that the individuality in metabolism with women between 70 and 86 years is pronounced, certainly much more so than would be expected with a similar sized group of medical students or a group of the youthful college age. With such groups one would expect to find one or possibly two with

a metabolism deviating ± 10 per cent from the prediction. With these elderly women, however, two had a metabolism more than 10 per cent above and four more than 10 per cent below the Harris-Benedict predictions. As has already been pointed out elsewhere,[1] in spite of the fact that usually the coöperation and the degree of repose are somewhat better with girls and women than with boys and men, nevertheless there is a much greater variability in the metabolism of the former. Our data with elderly women are in line with this finding. Thus, the percentage deviations from the Harris-Benedict predictions range from -17 per cent with a woman 66 years of age to $+15$ per cent with a woman 71 years of age. It is obvious that until much more material is available for women over 70 years of age, one can not state definitely what is the best method of predicting the metabolism of elderly women.

The finding that the Harris-Benedict formula predicts the metabolism of this group of elderly women so closely, on the average, is surprising for there has been a strong disposition in recent years to suggest that the Harris-Benedict prediction standards for women and, in fact, all prediction standards for women are too high by about 5 per cent.[2] With this group of women this is not suggested by the comparisons with the Harris-Benedict standards, but is definitely suggested by the comparisons with the Dreyer and the Aub and Du Bois standards. If, for the most part, normal women up to 60 or 70 years of age, studied at the present day, are found to have a metabolism about 5 per cent lower than the Harris-Benedict standard and this group of elderly women have a metabolism essentially the same as the Harris-Benedict standard, one could infer that we had to deal here with an exceptionally vigorous and healthy group of women, in view of their age. It is believed, therefore, that from the data obtained on our subjects a prediction method may legitimately be derived, although it is realized that statistically the number of subjects

[1] Benedict, F. G., *Am. Journ. Physiol.*, 1928, *85*, p. 613.

[2] MacLeod, G., Crofts, E. E., and F. G. Benedict, *Am. Journ. Physiol.*, 1925, *73*, p. 460; ibid., *Proc. Nat. Acad. Sci.*, 1925, *11*, p. 343.

is small and hence that a large element of speculation must enter into any prediction formula derived from these data.

SUMMARY

The basal metabolism of 23 women from 66 to 86 years of age (32 to 72 kg.) was measured with the helmet respiration apparatus, on from 2 to 4 different days in each case. The results on all bases of comparison show that the metabolism decreases with advancing age. All the women 78 years and over had a total heat production close to 1000 calories per 24 hours. The clinician might accept this value as applicable, without too great error, to women 78 years of age and above. For elderly women under 78 years the relationship between the measured heat production per kilogram of body weight and the weight, as shown by our group of elderly women, could likewise be used to predict with reasonable accuracy the probable basal metabolism. If this weight relationship is used for the prediction, it should be recognized that at the heavier weights the metabolism per unit of weight will be lower with women of more advanced age than with women in the 70-year old group.

There was no definite correlation between the blood pressure and the basal metabolism of these women. In spite of the popular and supposedly well-founded notion that individuals with great vigor have a somewhat higher metabolism than individuals of the slow, phlegmatic type, our comparisons suggest that those elderly women who had the greatest vigor had the lowest metabolism. This may be explained in part by the fact that those women rated as most vigorous were usually lightest in weight, and that, in the rating of vigor, the spryness that accompanies lightness in weight was confused with real physical vigor. The picture is complicated by the frailties of old age, notably the high blood pressure found in most instances, but it is the opinion of Dr. Lyman H. Hoyt that hypertension in these elderly women certainly produced no obvious disturbance in metabolism and may really have been of benefit.

The metabolism predicted by the Harris-Benedict formula agreed more closely, on the average, with the measured metabolism than did the predictions by either the Aub and Du Bois or the Dreyer standards. The predictions showed such wide divergences in many cases, however, that none of the existing standards may be considered to predict accurately the metabolism of any individual, elderly woman. Basal metabolism observations on normal, elderly women may be interpreted in future with a considerable degree of reliability, upon the basis of the measurements with this group of elderly women. But until many more elderly women have been studied, a more exact method for the prediction of the metabolism in old age may not be expected.

RECENT PROGRESS IN THE CONTROL OF LEPROSY

By VICTOR G. HEISER

(Read April 21, 1932)

It is generally agreed that there are at least several million persons in the world who have leprosy. We are said to have 2000 in the United States. Recent studies support the belief that a rapid reduction in the number of cases is possible. The banner of hope is being lifted higher and higher through the possibility of applying, to this end, principles that have been successful in the control of other diseases. Leprosy is one of the most repulsive ailments that afflict man, and since the earliest times exceptional efforts have been made to alleviate and to minimize its consequences. The attempts to deal with it in the past have been largely confined to giving kindly care to those afflicted. To the Christian Church should be given the credit of the major part in relieving the suffering of the victims and bringing them spiritual comfort. It is to science, however, that we must look for methods to reduce the incidence of the disease.

What, then, is the outlook in the world at the present time for the control of leprosy? It is an interesting fact that although there are many persons in England today who have leprosy, there are no indigenous cases. In other words, in the past fifty years there has been no authentic case which has been contracted in England. Practically the same thing is true of many parts of the United States; for example, there are many cases of leprosy in New York City, and yet no one has been able to point to a case that originated in the City or even in the State or the surrounding States. At one time persons contracted leprosy in Minnesota, but this no longer happens. Briefly, it may be stated that in the United States leprosy is transmitted in Florida, Louisiana, Texas, and Cali-

fornia only, although it is not so long since cases originated in many other States. It is generally assumed that a sufficient concentration of cases in any small area will soon result in the appearance of other cases among persons who frequently come in contact with the afflicted. A striking illustration of the danger of the spread of leprosy may be found in an experience on the Island of Nauru in the Central Pacific Ocean south of the equator. This island, which is about twelve miles in circumference and has a population of about 2500, is a former German possession which, since the World War, has been under the British Crown. In 1920 there were four cases of leprosy on the island; in 1921 there were 60; in 1927 there were 337, or about 1 in 70 of the population. Only recently there was an outbreak of the disease in Holland. Experiences such as these emphasize the importance of preventing the entrance into the United States of new cases and of dealing effectively with those already here which are a source of danger. This point should be stressed, for it is fairly well established that there are at least 2000 cases in this country, which is an increase of 1000 over previous estimates.

Fortunately, exceptionally good facilities have been assembled in the United States to check further increase of leprosy. The Federal Government has established in Louisiana one of the world's best hospitals, with every form of equipment for the treatment of leprosy. This institution has a well trained staff, technical workers, and special consultants. It provides as well many diversions for the patients, even to the point of supplying a professional golf teacher. There is a radio for each room. Moving-pictures are a feature, and a daily paper is published. In fact, so much is done for the patients that after their recovery they are loath to leave the hospital, and some return and plead to be readmitted. It is unfortunate that notwithstanding the excellent facilities offered, some States have not yet availed themselves to the full extent of this remarkable institution, and therefore are not doing their full part toward stamping out leprosy. Of the 2000 victims in the United States, less than 400 are at this colony. Such a situation should be corrected.

Data upon which to base a program for the control of leprosy throughout the world was outlined at a conference which took place in Manila last year. This conference was made possible through the munificence of the Leonard Wood Memorial for the Eradication of Leprosy. It will be recalled that the Wood Memorial came into existence recently through the gifts of the American people of some $2,000,000 to honor the memory of this well beloved soldier-physician. The conference was attended by the representatives of sixteen countries, all of whom had had wide experience in dealing with leprosy. Their prestige is such that their recommendations for the control of the disease have received wide acceptance. These, in brief, were the adoption of more effective methods of treatment and the application of principles similar to those which have been successful in controlling tuberculosis.

In the past man has achieved great conquests over disease by direct or by indirect methods. Plague, yellow fever, cholera, diphtheria, are examples of diseases that can be controlled with mathematical certainty by breaking a link in the chain of transmission. Bubonic plague, for instance, ceases at once if the flea responsible for its transmission, or the rat host of this flea, is eliminated. To bring yellow fever under control it is only necessary to eradicate one species of mosquito. Diphtheria disappears when susceptible persons are made immune by vaccination. Present day advance against tuberculosis is an excellent example of disease control by the indirect method. We lack the knowledge to break a link in the chain of tuberculosis transmission, and yet since the beginning of organized care of patients and preventive work there has been a tremendous reduction in tuberculosis. If the tuberculosis death rate of 1900 had obtained in the United States in 1929 we would have had 234,845 deaths from this disease instead of 88,352.

In leprosy, as in tuberculosis, we still lack the knowledge to attack the disease by breaking a link in the chain of transmission. The organism of leprosy, the mycobacterium, has been isolated, but efforts to cultivate it have failed, although

McKinley and Soule have recently described a promising method. It is not even possible to transmit leprosy to an animal, and this is a great handicap in advancing the study of the disease. But we need not stand still on this account. Taking tuberculosis work as our guide, we can, in dealing with leprosy, secure hygienic living among patients, the early treatment of cases, isolation, and the employment of other common sense methods, and thus secure effective results. In the United States, for instance, it ought to be possible to prevent the transmission of leprosy in the space of a few years. In the light of present knowledge it would only be necessary to send all the afflicted persons of Louisiana, Florida, Texas, and California, to the Federal Hospital at Carville. In these States active steps should be taken to find the early cases and have them brought under treatment. In countries like India, China, and Japan, where the large numbers of sufferers would involve prohibitive hospital costs, outdoor or dispensary treatment could be given and patients taught how to avoid endangering others. Movements of this kind should be directed by those who have had special experience in the diagnosis of leprosy. This presupposes that adequate training bases be maintained at places like Calcutta, Manila, and Rio de Janeiro, in addition to the excellent facilities available in London, Paris, Hamburg, Amsterdam, Honolulu, and Carville.

In recent years success in treatment has become an important factor in prevention. It is obvious, for instance, that if a child with an infective lesion is promptly discovered and successfully treated, a most important focus of infection is eliminated. In brief, it is the extraordinary progress in treatment that makes reduction in the incidence of leprosy so promising. So far as the records show, it was not until the twentieth century that anyone recovered from leprosy as a result of treatment. Today the Hospital at Culion in the Philippines alone reports over 2000 persons as having recovered from the disease and been restored to their homes and friends. Proportionate results are reported from many other places throughout the world. These results have been largely

due to the use of chaulmoogra oil in some form. It had been known for some hundreds of years that chewing the bark, twigs, or leaves of the chaulmoogra tree had a beneficial effect on leprosy. Gradually it became known that the oil was the effective agent and that from the nut of the tree the greatest quantity of oil could be extracted. The fact that the oral administration of the oil caused severe nausea retarded its extended use until a method of administration without nausea was applied in the Philippines. Since then progress has been rapid and thousands have been rescued from living death.

A review of many treatments that have a beneficial effect in leprosy suggests that it may be their capacity to cause fever to which they owe their virtue. Recently it has been shown that the administration of chaulmoogra oil causes fever in at least a certain percentage of cases. In Wayson's experience in Honolulu fever was caused and good results were obtained by injecting olive oil combined with sulphuric acid, and Denney in Carville has had similar success with the use of smallpox vaccine. It has long been known that hot baths have a beneficial effect, and it may be that the elevation in temperature following their use has given the hot springs of Japan and other places their reputation as helpful agents in leprosy control. This opens up other promising leads in treatment. For instance, plans are under way to use the radiotherm, a machine created by the General Electric Company to produce fever and said to have been used with success in the treatment of arthritis.

At the International Leprosy Conference at Manila in 1931 particular attention was directed to the unfortunate consesequences that are inherent in the use of the word leper. In this lies another analogy with tuberculosis. It will be recalled that it is not so many years since a person suffering from tuberculosis had the stigma of being called a consumptive, and the use of this term resulted in unreasonable prejudice against the unfortunate person. Such has been the history of the word leper. The one is no more necessary than the other, and humane considerations alone should compel its abolition.

THE ART CALLED MODERN

By HARRISON S. MORRIS

(*Read April 22, 1932*)

THIS title is much like the Biblical phrase: "Simon called Peter."

Nobody knows why Simon was called Peter. It would have meant an economy of words if he had been called either, but not both.

So it is with the Art called Modern. It is neither one nor the other. It is neither Art nor Modern.

For its devotees tell us they are derived from Giotto or El Greco, and neither of those celebrated artists of old can, by any stretch of fancy, be classed as Modern.

Giotto hails from the thirteenth century. He brought into Europe the fashion of Byzantine painting. Anybody who descends into the airless underground chapel at Assisi may see his archaic work in full display. The primitive forms of his men and women are encased in even more primitive buildings. The art of perspective had not yet developed in the artist's eye. Action is arrested by infantile drawing. The value of the long row of mural panels lies, to us, in its very antiquity.

Of El Greco in the sixteenth century, much the same thing may be said. He is sometimes charged with astigmatism, with obliquity of vision, because his figures are grotesque in their exaggeration of human anatomy. The long, narrow bodies, the elongated necks (vide the Modernist, Modigliani) and gaunt faces would be laughed into oblivion if he were not so impressive a painter.

These, then, with Ingres, the most realistic and exact of French portraitists, are the chosen artistic patron-saints of Modernism in paint.

But, why must an art called Modern build itself on these antique examples? Why must an art vociferously proclaimed as original, have any antecedents at all?

They will tell you that Art must go back to its infancy; that it must return to Nature. But if this excuses the entire lack of ideas, the absence of invention, the reliance on antiquity as a source of material, while the teeming and unprecendented life of today streams around them—they are ignorant of the uses of art, oblivious of its history.

Giotto worked out his own salvation in paint by carrying the methods of oriental art into the production of the Biblical subjects prevailing in his own day. He set down in color the spirit of his time. He was original in his conceptions because he represented what belonged to his age and place.

El Greco depicts the currents of his time in character and subject and in pious inspiration. His idiosyncrasies were completely his own.

If these great artists had not so painted; if they had copied some other age, some other high period; if they had taken their impulses from enduring and original artists of earlier times, they would not now be living forces in art. Art that lasts must express the period of its creation.

Titian painted the "Entombment," although the event occurred fifteen hundred years earlier than his own birth. Yet that masterpiece expresses the sentiment, the human types, the grace and form, and the manners of his age.

Thus in treatment and in technique, works of art live by picturing the character of the artist, his sincerity and his perception and love of beauty in its contemporary forms.

So much for the claim of Modernity.

Now let us analyze the asumption that this sort of painting called Modernism is art.

To ask what is art is to encounter confusion. There will be as many definitions as there are critics. There will be the learned answer of the connoisseur, and the flippant note of the man who "don't know much about art, but who knows what he likes."

But, after all, and lying profoundly deep in human consciousness, there is a standard that wisdom and education and taste, revere and acknowledge. The works of art that have endured through the centuries show this. You can recognize in them a unit of beauty that holds them kin, though they vary in style and subject and execution, according to their period.

But these so-called Modern freaks, spawned by anarchy and war, the negation of all ideas, of invention, of even the intelligent use of paint, how can they hope to possess that one substantial evidence of beauty—endurance. How can the half-baked tyros, who forget that painting is a noble art, that it is no ephemeral adventure, no sly game to catch conies, how can such expect for their sloppy and often indecent canvases any life "beyond the morrow" ?

No, art is something new, born from the womb of the old, but with fresh and youthful beauty; beauty that the eye, educated by Nature and by commerce with the best the world has saved from its past, accepts at once as man's highest reach in creation.

If we could put ourselves back historically in the period in Paris before the birth of what was called Impressionism; and with our present senses see its rise, with new ideas, new strength, new delineation, new search into the meaning and inevitable taste of Nature—then we could the more surely divine what is art when it truly emerges into a new evolution of its hereditary beauty and truth.

But this art called Modern, does it belong on the stem of the evolving life of all painting? It is filled with a love of Nature and with the technical skill of its calling? Any eye may see that it is false in these essentials. Its imagination is barren; its fancy spiritless; its meaning obscure or vulgar.

And it is to this last effect that it owes much of its ephemeral currency. Without the appeal to sexual allurement, it is doubtful if the Art called Modern could have survived even for its few years of vogue. This and the favour of that sort of Society that tilts on the crest of novelty, have given it

an artificial strength—not to speak of the sly nudges from Semitic Paris. Jewish and other dealers there and in New York sell by adroit suggestion to the silly "Intelligentsia," who consort with over-ripe specimens of wealthy old society—tired of themselves, and wanting the decay of high cheese.

Thus they have served to them such titillating morsels as those in a New York show of a year ago. Here Derain, whose name sounds suggestively like Drains, was represented by a nude female torso without head, without feet—only the most appealing members exposed.

This to me well typified the subtle motive that holds the devotees. You may cast away the head; that stands for intellect, for character, for love of robust life, for beauty and truth. And the feet may be cut off, they typify the walk with Nature; the study of its revelations, its companionship. But expose the elements decently concealed by civilization, and you are emancipated from "Old Hat"; you are superior to the noblest conceptions of man's past, you have in fact achieved imbecility.

I mention only one such specimen. They, in their variations, are plentiful. The John Quinn collection sold in New York, was conspicuous with them. Nearly every show of the Art called Modern must have its specimens. They are the foundation of the system.

But, of course, the offense against taste and beauty, and the break with all artistic evolution, goes even deeper. The amount of it committed is an avalanche. It is easy to produce. You don't have to work, you don't have to think, you needn't know how to draw; the feeblest tyro may spoil paint and canvas after the recipe set by the leaders. Glance at Picasso, at Bracque, at Utrillo, and the rest; and you can see how it is done, and beside, there are others who know better, who consciously betray artistic ethics. Here is Matisse, an amateur in art; a doctor, I believe, who can paint moderately in the formula of true technique, but who affects a style in the current of outlandishness, for what? For notoriety, or gain, or what not? Here is Modigliani, no clear idea in his

own head, painting heads like toy balloons on a string; the face of toy-balloon red, the thin elongated neck serving for the string—flat, and false in every feature. Here is Rousseau-Douanier, the Custom House clerk producing nursery tigers he has never seen, nor anybody else, in a forest that never was on sea or land.

They will tell you that they are evangels of originality, in painting; but they all paint the same. They all produce, in the words of one of their friends, "tired apples falling off a tilted table." They specialize in easy flowers in bowls and vases on equally tipsy surfaces. Why cling to drawing? Drawing is outmoded.

And they claim that they are justified in this new Art called Modern, because—well, because it is attacked by a conventional public and by cast-iron critics. Wasn't "Impressionism" in the Nineties attacked and ignorantly spurned? Well, we also are attacked and spurned. Doesn't that prove we have founded a new art? Who could have foretold that the 1830 Romantic School of France, derided and hooted, would be the art of the future? Who could have predicted that "Impressionism" would last beyond the turning age? So we—we are proven to be the only art of our time and time to come, because we also have been derided and hooted.

Now that is the false syllogism which enables adolescents of our melting pot, without education, to swing a brush or to model in plaster the figments of what they call their minds, in color like nothing but so much mud, with subject sordid by choice, with shadows exaggerated because Cesanne and Von Gogh so expressed them, with no rational conception of the sensitive art they are thus destroying.

And, wilfully or not, they rely on this negation of logic,—that, because they are denounced or misunderstood, they are in the class with the Romantic or Impressionistic perfection, with Manet and Monet and Sisley and Pizarro and with Fantin-Latour.

Well, there is more in this opposition in their case than they think. It is the natural recoil of the normal man against

what is false. He will stand much. He will permit the lower elements of life to govern him in his cities; he will accept fantastic theories because they are called sacred; but the worm will turn, and it seems almost like breaking the butterfly, that indeed started life as a worm, to waste words on this Art called Modern, which is happily sliding off the scene as its painted apples slide off the tilted tables.

THE AMERICAN COUNCIL OF LEARNED SOCIETIES AND ITS RELATION TO HUMANISTIC STUDIES

By WALDO G. LELAND

(*Read April 22, 1932*)

THE American Council of Learned Societies devoted to Humanistic Studies is the unabridged title of the organization with which this brief account is concerned. Unkind critics have complained that the name is not only long but pretentious. Yet while the organizers of the Council recognized and regretted the inconvenient length of its designation, which they desired to be accurately descriptive, they were conscious, when making their choice, of the humility that is becoming to scholarship. In 1919, when the Council was organized, the scientists had already selected for their analogous body the simple but comprehensive title of National Research Council, in which, however, there was no place for research in history, in archaeology, in language, in literature, in the arts, in economics, or in the social sciences. The American Council of Learned Societies modestly described its field as the Humanistic *Studies*, not *Sciences*, and the expression "Learned Societies," is, after all, merely a consecrated term to distinguish the bodies to which it is applied from scientific societies, on the one hand, and professional organizations on the other.

While the immediate occasion for setting up the Council was the need of a national organization embracing the generality of American scholars, in order that the latter might be represented in the newly organized International Union of Academies and participate in its activities, the still greater need had long been felt of a close and visible union between groups of scholars whose interests were so nearly related but whose formal organizations were widely separated and badly in want of more effective means of intercommunication.

The Council, designed to meet this need, is a federation of eighteen national societies devoted to the disciplines that are not included in the programme of the National Research Council. The organization, in 1923, of the Social Science Research Council, with its seven constituent societies, five of which also belong to the American Council, brought about a division of labor between the two federal bodies, and enabled the Council of Learned Societies to devote its attention entirely to the humanities. This division also necessitated a definition of the respective fields of the humanities and of the social sciences. The definition of the former, adopted for purposes of awarding grants-in-aid and fellowships, includes philosophy, philology, literature and linguistics, archaeology and art, musicology, anthropology, history (with emphasis upon cultural and intellectual history), bibliography, and the so-called auxiliary sciences, such as epigraphy, palæography, chronology, etc.

The definition is admittedly a practical one, and in history and anthropology its application presents certain difficulties. The social sciences are obviously humanistic, and the humanities are indispensable to the social sciences, but in each group there are well-recognized lines of interest, natural affiliations, and common methods and techniques. By the maintenance of close relations between the two groups, dangers of competition and duplication of effort, as well as dangers of oversight and neglect, are avoided.

Without resources, however, both councils would have remained paper organizations, capable of little more than the expression of opinions, the adoption of resolutions, and the entertainment of hopes, and, during its early years, the activities of the American Council of Learned Societies were indeed restricted to these exercises of faith. Its income was derived from annual dues paid by its constituent societies, on the basis of five cents per member. At its fourth annual meeting, total receipts of $800.33 and disbursements of $680.81 were reported. While the marble palace of the National Research Council was rising opposite the Lincoln

Memorial in Washington, the representatives of the Learned Societies were grateful for the hospitality which the Institute of International Education in New York offered to their secretary and to their annual assembly. The *Dictionary of American Biography* was planned on a fund of $500 solicited personally from ten patrons of learning.

Such courage, if that is what it was, did not go unrewarded. In 1923 there came a subvention from the Carnegie Corporation; a little later the public-spirited offer of our fellow member, Mr. Adolph S. Ochs, to finance the *Dictionary of American Biography* to the extent of half a million dollars, seemed to the Council to open up before it a celestial thoroughfare paved with gold. Further subventions from the Carnegie Corporation, the Laura Spelman Rockefeller Memorial, the General Education Board, and the Rockefeller Foundation, followed. By the end of 1931 the Council had secured direct support aggregating over $1,800,000, from nearly sixty different sources, while additional indirect support, not passing through the Council's treasury, brought the total to something more than two million dollars.

To our scientific friends these figures will doubtless seem very modest, but they should be compared, not with what others may have, but with what the humanities themselves had less than a decade ago. Furthermore, years of frugal living have developed habits of cautious, not to say reluctant, spending.

If emphasis seems to be laid upon this material aspect of the subject, it is because the first service of the American Council to the humanities, indeed the necessary condition of the others, has been the securing of material support.

How has the Council organized itself to apply these resources, and what use does it make of them?

The organization of the Council is exceedingly simple. Two representatives of each constituent society bring its membership to 36; a single meeting is held each year, at which the annual budget is adopted and most of the appropriations voted; an executive committee of five members, including

the three officers (chairman, vice-chairman, and secretary-treasurer) conducts necessary business between the general assemblies, and, if the need arises, places questions before the Council for decision by postal vote, or calls it in special session. The Council is assisted by numerous committees, appointed in large part from outside its own membership. Of these, the Advisory Board examines applications for assistance and makes recommendations thereon to the Council; the Committee on Mediterranean Antiquities specializes in projects lying within its field; other committees are chiefly planning bodies, while still others are charged with the direction and execution of projects. Grants-in-aid to individual scholars and fellowships are administered by a special committee.

The executive offices, located in modest quarters in Washington, are the Council's administrative agency; they have a staff of nine persons (including two on part time), headed by the Permanent Secretary, and it is their task to furnish the secretariats of all the committees, to disburse the Council's funds, and also (and especially) to assure their replenishment, to keep closely in touch with all undertakings, some of which they direct, to make special studies, gather information, propose new activities, recommend policies, and in general to perform all the functions of an exceedingly busy *cheville ouvrière.*

The effective force of the Council, including its committees and the executive staffs of its projects, numbers approximately 200 persons; rotation brings about frequent changes, and the organization is at once flexible and representative. The Council and its constituent societies make up an ensemble based upon the membership of the latter, which exceeds 20,000.

The activities of the Council cover a wide range of interests and are varied in character, but they may be described in three principal categories, namely, planning and development, training and encouragement, and projects of research and publication.

The activities of the first category—planning and develop-

ment—are carried on by the Council in its capacity as a sort of general staff of the humanities. They include the preparation of surveys and special studies, the inventorying of materials essential for research, the holding of conferences, and the maintenance of committees charged with promoting the interests of selected fields of study.

The first survey conducted for the Council was of general scope, under the title *Research in the Humanistic and Social Sciences*. It was made by Professor Frederic A. Ogg of the University of Wisconsin, and its results were published in 1928 in a substantial volume (New York, Century). The enquiry was directed to the conditions, facilities, aid, and encouragement furnished by universities, colleges, libraries, societies, institutes, government agencies, and foundations, and the findings, together with the accompanying accumulation of basic information, have been of the utmost service to the Council and to institutions and organizations of related interests. But the survey made it, above all, clear that our opportunities in the fields it covered are still for the most part before us. It was chastening, but stimulating, to reflect upon the following conclusion reached by Professor Ogg:

> "The meagerness of first-rate American contributions to philosophy, philology, political science, and even history and economics —although the showing is somewhat better in these two fields— plainly reveals the immaturity of our culture. Plenty of research work, of a kind, is all the time in progress. Quantitatively, there is little ground for complaint. But a considerable proportion of the studies undertaken are ill-planned, crudely executed, and barren of significant result."

To improve the situation thus described is recognized as a principal objective of the Council.

Two special studies have been devoted to the publications of the constituent societies. The first, by Mr. John Marshall of the Mediæval Academy of America and also of the Executive Offices of the Council, deals with book or monograph publications of the several societies. It reveals, among other things, that twelve societies have spent in recent years

$114,800 to publish 59 books. Editions totalling 64,700 copies have been printed, of which 19,600 copies have been distributed gratuitously, 12,300 copies have been sold with proceeds of $41,000, while the stock on hand, awaiting sale, amounts to 28,000 copies priced at $113,300. Such a showing should teach a number of useful lessons. If the demand for carefully selected books of scholarship published by the principal learned societies, whose aggregate membership of many thousands represents nearly the entire market for such works, is so slight that the average sale is barely 200 copies per book, it seems clear both that methods of salesmanship must be improved, and that methods of manufacture must be altered, cheaper processes employed and smaller editions issued.

The second study of learned society publications, dealing with American philological journals, is not yet completed, but it promises to be informing and significant.

An important committee devoted to planning is the Joint Committee on Materials for Research maintained by the Council of Learned Societies and the Social Science Research Council. This committee is endeavoring to promote discussion among scholars as to hitherto unused or neglected materials, and many interesting suggestions have resulted. Anthropologists, for example, have pointed out that the abolition of ancient cemeteries and the transfer of their contents afford an opportunity to measure the skeletal remains of our ancestors, furnishing information which they themselves neglected to compile for us, and supplying a basis for instructive comparative studies.

The Council of Learned Societies is gathering information respecting a variety of research materials. The *Corpus of Ancient Vases*, under the direction of our fellow member Professor George H. Chase, of Harvard University, will include photographs and descriptions of all the important classical vases in this country, and will be a part of the international corpus sponsored by the International Union of Academies. Similarly, the *Catalogue of Foreign Manuscripts in the United*

States and Canada, executed by the Library of Congress with the aid of a subvention secured by the Council, and now nearly completed, will include a description of all our Greek and Latin manuscripts, and will meet one of our outstanding obligations to European scholarship.

A survey of the Collections of Chinese art and literature in American museums and libraries indicates that our resources in this field greatly surpass those of all other countries save China and Japan.

Special attention has been given to completing important bibliographical tools of research long under way but in danger of remaining unfinished, such as the famous work commenced by Joseph Sabin half a century ago, *Dictionary of Books relating to America;* the equally useful and monumental *American Bibliography* of Charles Evans; and the American Historical Association's long-awaited *Bibliography of American Travel.*

The Council maintains five standing committees on the advancement of as many fields of work: Chinese Studies, Japanese Studies, Indic and Iranian Studies, Byzantine Studies, and Musicology. Of these, the Committee on Chinese Studies is the most active. Its general survey of museum and library materials has been mentioned; it also publishes an annual *Bulletin on the Progress of Chinese Studies in the United States*, and has secured a fund for an annual volume of selected articles on sinological subjects by American scholars. It is especially endeavoring to attract a few promising students to a field of study that offers unusual opportunities, and has arranged for a Seminar at Harvard University this coming summer, where college and university teachers who are obliged to give courses dealing with Far Eastern subjects, but who lack definite training in that difficult field, may receive the special instruction that they need. One of the most interesting projects of the Committee, for which funds have been received, is the translation into English of the more important of the dynastic histories, thus laying the foundation, it is hoped, of a great collection of sinological

monuments translated into one or another of the principal Western languages.

The Committee on Japanese Studies finds itself with a disconcertingly clear field, in which not more than two or three American scholars are capable of carrying on research. The Committee's most important task therefore, the accomplishment of which will require a generation, is to bring into being a group of qualified workers.

The Committee on Byzantine Studies is faced with a problem similar in kind, if not in degree, while, on the other hand, the Committee on Indic and Iranian Studies could easily produce small annual crops of promising students, if opportunities for successful careers were not severely limited by the fact that most of the eight university departments of Sanskrit are manned by discouragingly young or by exceedingly well-preserved professors. Meanwhile the Committee has plans, and some funds, for the founding of an American School of Indic and Iranian Studies in India.

The Committee on Musicology has to deal with a field of study that, in America, hardly exists. A survey of the general situation, including library resources and college and university instruction, is being conducted, but the Committee has been obliged to confine its attention almost entirely to projects of publication, such as the *Corpus of Medieval Songs* of Professor Jean Beck, or the *Thesaurus of Hebrew Oriental Melodies* of Professor A. Z. Idelsohn, both of which it has assisted.

The second category of the Council's activities, training and encouragement, may be described more rapidly. Each year a dozen or more post-doctoral fellowships are awarded to scholars not over thirty-six years of age, who have displayed unquestionable aptitude for careers of research. Fellows have been appointed for work in most of the European countries, in Africa, in Asia, and in America. The system has been in effect less than two full years, and its results cannot yet be accurately appraised. In many cases they are rather intangible and will manifest themselves indirectly during the next decade.

Encouragement to research is by means of grants-in-aid, ranging from \$300 to \$1,000, which are awarded to scholars who are engaged in promising investigations, and who actually need assistance in meeting the expenses of their research. Between thirty and forty such grants, aggregating about \$20,000, are awarded each year. The results have been uneven, but on the whole encouraging. While the larger grants are reserved for older scholars of demonstrated and distinguished competence, chances are sometimes taken with the smaller grants in the hope of bringing to light unrecognized ability.

The activities of the third and last category, projects of research and publication, must be treated briefly and by illustration, for the recital of them all would be nearly as long if not as tedious as the catalogue of the ships.

Of the projects organized, supported, and directed by the Council, the most considerable are the *Dictionary of American Biography*, which is well enough known to make any description of it superfluous; research in Native American Languages, directed by Professor Franz Boas; and the *Linguistic Atlas of the United States and Canada.* These three distinctive American undertakings are outstanding obligations of American scholarship. The preservation of the rapidly dying aboriginal languages of the New World is by no means mere linguistic antiquarianism, but is essential to the study of primitive language, and vital to any synthetic study of native American culture.

The Linguistic Atlas has been inaugurated with a study of New England dialect, which is being conducted by a specially trained staff, under the direction of Professor Hans Kurath, located at half a dozen New England universities and colleges, with administrative headquarters at Yale. It will be completed in about two years. and will provide a permanent record of the peculiarities of English speech in a region where primary dialect is still to be encountered. The value of such a record extends beyond linguistics into literature, history, and sociology.

The Council has adopted two large-scale projects of individual scholars and supports them by means of special funds. The History of Pre-Aristotelian Greek Thought, undertaken by Professor William A. Heidel of Wesleyan University, is one; the other is a Palæographical Guide to Latin Manuscripts prior to 800 A. D., by Dr. E. A. Lowe of the Carnegie Institution of Washington.

In coöperation with learned bodies of other countries, under the auspices of the International Union of Academies, the Council is engaged in preparing a corpus of the Latin translations of Aristotle, in collecting material in the Philippine Islands relating to Indonesian customary law, and in compiling a new *Dictionary of Medieval Latin.*

Among the undertakings aided but not executed by the Council may be mentioned several carried on or sponsored by its constituent societies: a dictionary of Middle English of the Modern Language Association; the publication of Bloomfield and Edgerton's great work on Vedic Variants, by the Linguistic Society of America; the compilation of a glossary of medieval Italian terms of business, detailed studies of the organization and operation of the various branches of the English government during an early decade of the fourteenth century, the history of Anglo-Papal relations to the Protestant revolution, and an edition of the commentaries on Virgil by Servius—all these of the Mediæval Academy of America.

The list could be extended to include assistance to the archæological excavations of Olynthus, Antioch, Samaria, Haifa, and Jerash, to the monumental corpus of Florentine painting of Professor Richard Offner, sponsored by New York University, and to many other undertakings, but it is already long enough, and must end here.

After this rapid survey of the Committee's operations it is natural to enquire what conclusions are to be reached as to the present state of the humanistic studies.

The experience of the Council, although extensive, has been too brief to make it safe as yet to indulge in definite formulations. Certain problems and needs and trends are

becoming manifest, but most important of all is the attitude of scholars themselves towards their work.

In the first place it has been found that the responsibility of selecting projects and of spending one's own money upon them is very different from the responsibility of planning enterprises which it is hoped others may be induced to support. This different sort of responsibility is exceedingly useful in acquiring a broader view of needs and opportunities, and in developing a keener sense of comparative values.

In the second place there is increased recognition of what the humanities have in common—their methods, their techniques, their problems, and their objectives,—which is rapidly breaking down the compartment system that resulted from too exclusive specialization.

Finally, there is more widespread impatience with easy accumulations of facts which correspond to no important need, with super-refinements of technique which result in no useful improvements of method, and with research in a vacuum the results of which are trivial and unrelated to significant problems.

But it must not be inferred that the reaction thus described is something new, or that the unscholarly qualities against which it is directed are confined to the humanities, or that they are of greater occurrence there than in other fields, or that the humanities themselves are "going practical."

WASHINGTON

By PAUL VAN DYKE

(Read April 22, 1932)

One of the greatest public speakers America has produced gave this piece of advice to those about to speak in public, who lacked his skill: "Always begin by taking the audience into your confidence." I am going to follow his advice by telling you simply how I came last year to write a little book called "Washington, The Son of His Country," which, I am informed, brought me the great honor of an invitation to speak before this distinguished assembly of adepts and connoisseurs of letters, science and the arts.

I hesitated for some time whether to call this paper the Lovable George Washington or the Human Washington. The first is the more accurate, but he who writes of Washington nowadays is often obliged to choose the less accurate phrase. A more accurate one might cause my motive in writing to be misunderstood. I should not like to have my opinions classified among those of the sickly sentimental adorers of our great man, freeing him from all the weaknesses that flesh is heir to, attributing to him capacities he did not show in order to make him great. The word lovable does not imply this, but, to some people, it might suggest that I was one of the Washington adorers who were restoring for him the classic apotheosis. Human seemed safer.

Now I must further confess to you that up to three years ago George Washington did not seem to me lovable and largely because he did not seem to me really human. Three years ago when I was in Paris for the American University Union I found myself with some spare time and determined to add a volume to my little shelf of seven, but this time in the field of American history. I had not planned to write on Wash-

ington but on some general theme during the first two generations of the Eighteenth Century, a period less fully occupied by American writers than others.

I began by reading all the writings of John Adams and George Washington and Washington took me captive. I began to feel, as I got one authentic little light on his character after another, that my conception of him, stiff, selfconscious, unapproachable, was incomplete and false. I began to know this man and the more I knew him the more I liked him. I could not rest until I knew all there was to be known about him on authentic testimony, eliminating legend. I studied especially, not Washington after he took command of the Continental Armies, Washington the great man, a European figure—but the Washington of the wheat and tobacco fields of the Potomac and the all but unbroken wilderness of the Ohio watershed; a Washington who after suffering the great misfortune of being involved in international propaganda which falsely accused him of murdering the bearer of a flag of truce, dropped out of the sight of Europe for seventeen years and was known chiefly in Virginia until he emerged again as the leader of American Republicanism against English royalty.

One of the first things I learned about George Washington was to forget some of the things I had been told about him. For instance, a great political leader has written of Washington as if he was a typical English country gentleman living on the banks of the Potomac instead of on the Thames, but otherwise not very different. He was supposed to have been taught correct manners—presumably for English country society, by Thomas Lord Fairfax, whose vast Virginian estate Washington helped to survey. But if there is a scrap of evidence going farther than mere conjecture that Lord Fairfax had any special influence on this young man sixty years younger than himself, the editors of the New Dictionary of National Biography evidently don't know where it is. Who knows whether Lord Fairfax, who lived a secluded life, could teach George Washington English manners or anything else

except perhaps fox hunting, which George might have learned elsewhere. As for the English country gentlemen, who among them, except some of the younger sons and brothers, had any experience like Washington, who at sixteen faced the discomforts and dangers of surveying in the wilderness and at twenty-one went hundreds of miles on a winter journey through the dangerous forest haunted by treacherous Indians.

If George Washington was not different from the average English country gentlemen it is very strange. As a matter of fact he was not an English squire but a Virginia planter. He was a son of his country, that was the prerequisite for becoming the Father of his Country. Imagine Steuben or Kosciusko or even Lafayette, keeping the army together or guiding the constitutional debates.

This does not mean that Washington was the product of his environment. In spite of what has been called "the lush vocabulary of modern psychology" most men still believe that there can be no development without something to develop. Of the friends and associates of Washington who had breathed for forty years an atmosphere like the one he breathed, who could have taken his place? Not Peyton Randolph, George Mason, William Fairfax, R. H. Lee, Patrick Henry, Richard Bland, Benjamin Harrison, Edmund Pendleton, or Charles Carroll.

His environment made him one of many sons of his country, but he was himself.

Another thing one must do to know the human Washington is to blow away a certain air of mystery that a number of writers have thrown about him. I bow with great respect to their scholarly authority but I cannot accept their conclusions. A man who has long stood at the top of the list of writers on American history said: "George Washington is an unknown man." Channing wrote: "No more elusive personality exists in history." Châteaubriand wrote: "An atmosphere of silence envelopes the deeds of Washington." This winter a professor of our oldest university wrote: "To his own people George Washington is the cloudiest of all the great figures.

In the one hundred and thirty odd years since he died, he has gone farther away from us than Marc Antony who died 2000 years ago. Of all his contemporaries he is the least real. Around Washington there is a stiff silence and the night of time." Well, if a man feels that Washington has fewer points of conduct with him than Marc Antony has, I do not know what you can say. I suppose all of us average men are apt to assume something mysterious in the personality of great men to account for those results which the average man is aware he could not produce. This is perhaps a survival of the ancient feeling that the birth of great men must have been heralded by portents.

But really, and with all due apologies to those with whose opinions on this point of mystery about George Washington I cannot agree, there is nothing mysterious about him. He is a thoroughly human person. If you had bought a plantation next to Mt. Vernon you would have been glad to have so kindly, cheerful, fair and good a neighbour during the seventeen years between his five years' service against the French and Indians and his eight years' struggle with the British Crown. During this time he grew into a typical Virginia planter of the best sort. Hospitable as an Arab—an open air man whose work and whose play kept him out of doors in the saddle, making long rides to inspect his farms, to put up and chase a fox, to visit his neighbours, to ride to the vestry meeting of his parish or to the Assembly of Virginia as a Burgess. We know that he imported good wine for his guests from Madeira or from France by way of England and that like most of his neighbours he bottled hard cider and distilled whisky and brandy (all big plantations were apt to have a distiller among their slaves or other workers). Later he wanted the Congress to own distilleries in order to be sure the soldiers got their rations of good liquor which, experience of all countries, he said, had shown was necessary for an effective army. This is the reason why the pastor of a church recently refused to allow the use of his building for a Washington Celebration—because *George Washington drank!* This in

spite of the fact that it was long after Washington's death before any effort to promote temperance by abstinence and prohibition was made.

Then again there are other moderns who are visibly, though perhaps subconsciously, delighted to be able to suggest that the two thousand guests recorded in his journals during part of seven years and a half when he was at Mt. Vernon, enabled him to preside over a series of cocktail parties. Now as a matter of hard fact without any relation to prohibition one way or the other, I do not know of one instance of trustworthy evidence that George Washington ever took more to drink than he could carry like a gentleman. Weems cites one instance as trustworthy as the details of the cherry tree. Washington's great critic the tory Boucher says on the other hand, "he is regular and temperate." Besides it does not fit into the rest of the picture. George Washington had too much self-control to slip into the cheap and vulgar folly of excessive drinking.

Among lewd fellows of the baser sort, there have apparently always been flying around unsavoury stories about Washington's relations to women. Such stories are apt to arise and live in the modern equivalents of old country barrooms, apparently because they ease the unconscious envy of men who are glad to believe, with or without proof, that Washington was no better than they are. As for proof there is none. All there is has been collected by Washington's new editor into a number of Scribner's Magazine, where he shows them to be blatant forgeries. George Washington was in every respect a good husband to Martha.

His letter to her announcing his election as commander-in-chief can be put along side of Cromwell's letter to his wife from the field, as a deep expression of tender solicitude in a strong man overwhelmed with work and responsibility. It fulfills the promise of his only love letter to her which has survived. "We have begun our march from the Ohio. A courier is starting for Williamsburg and I embrace the opportunity to send a few words to one whose life is now in-

separable from nine. Since that happy hour when we made our pledges to each other. My thoughts have been continually going to you as another self. That an all powerful Providence may keep us both in safety is the prayer of your every faithful and affectionate friend." This is not very Byronic but it is a pretty good middle of the Eighteenth Century love letter.

Some fifty years ago five of George Washington's letters written about the time this was, came back from England where they had been since before the beginning of the Revolutionary War. Two of them show beyond the shadow of a doubt that when George Washington married the rich young widow, Martha Dandridge, he was in love with another woman; Sally Fairfax, the wife of a very intimate friend and neighbor who lived near Mt. Vernon at Belvoir. These two letters are all we know about it. That they indicate anything else than indiscretion in giving words to what ought to have remained buried in silence, there is nothing to indicate.

The Fairfaxes went to England shortly before the outbreak of the War of the Revolution, where the husband died. George and Sally neither saw nor heard of each other for twenty-five years. Then shortly before his death George wrote to Sally to come back and finish her days among old friends on the banks of the Potomac. Martha joined heartily in the invitation and George put into his letter. "During five and twenty years many changes have taken place and many important events have occurred which the compass of a letter could give you but an inadequate idea of. None of these events nor all of them have been able to eradicate from my mind the recollection of those happy moments, the happiest of my life, which I have enjoyed in your company." All three of these people were nearly seventy. It was the rather pitiful attempt of an old man to recall to life, affections long past, through whose dangers he had passed with honor. It has been shrewdly conjectured by a modern writer that Martha knew all about her husband and Sally and contributed patience and trust to the safe solution which came. If

we had some of Martha's letters they would probably show that she had more tact and more power of tactful utterance than some moderns apparently believe—else they would not allude to her in such a half depreciatory tone. Here, for instance, is a letter she wrote to Nelly Calvert who was about to marry Martha's young son, Jacky Custis.

My dear Nelly.

God took from me a daughter when June Roses were blooming. He has now given me another daughter about her age when winter winds are blowing to warm my heart again. I am as Happy as One so afflicted and so Blest can be. Pray receive my Benediction and a wish that you may long live the loving wife of my happy son and a loving daughter of

Your affectionate Mother.

This sounds almost too literary to be genuine, but Lossing says he copied it in 1860 from the original in the possession of the family at Arlington.

Perhaps after all they are not so much to be pitied. George had his memories and his work and the faithful companionship of Martha. Martha had George. Sally lived in England a long and lonely life after her husband's death. Who of us has his dream or having it finds it all he had supposed? It was weak in George to let his control break down and write those letters, but he is not the first nor the last man to try to heal the wounds of one woman by marrying another.

It is difficult for me to understand the imagination which finds in this story as it lies in five letters and not in my poor telling of it anything but a melancholy beauty and the pain and temporary weakness of a strong man.

Next to love comes religion and here I find myself in trouble. A rector of a New England church sends to the press a somewhat heated protest against a statement made at Symphony Hall during the Boston Municipal Celebration of the Washington Bicentennial by the editor of the *Commonweal.* The editor quoted my book to the effect that there is no trustworthy proof that George Washington took the communion. He might also have cited it to the effect that he

was a rather regular attendant on public worship and a very faithful attendant for years on vestry meetings. It would go without saying that, for a man of Washington's position, there was only one denomination with which he would associate himself—the English Church; which was the Church of Virginia as well as of England. I might have added that there is testimony, entirely authentic, that, when one of Washington's rectors remonstrated with his august parishioner for leaving the church in the interval before the celebration of the Sacrament, Washington solved the difficulty not by remaining for the celebration, but by staying away from services which were followed by the sacrament. The good rector is apparently much hurt by what he calls "this most amazing attempt to discredit Washington's very definite allegiance to the Church of England." But surely he knows that historians don't try to discredit anything or anybody; they only try to establish the facts and deduce from them the truth. George Washington was a faithful supporter of the Established Church and later of the Episcopal Church, but his religion was without dogmatic content—it lacked what is called evangelic fervor and certainly it was without ecclesiastical denominational zeal. I cannot imagine him suspecting in anything I have written any attempt to "discredit" anything or anybody or any relation

On the other hand this gentleman who seems so extremely anxious to assert that George Washington was in all respects a very perfect Episcopalian, seems to me nearer the truth in regard to Washington's religion than one of my colleagues of the faculty of the oldest of our Universities who writes: "In Washington's more formal papers there are the usual expressions of trust in an over ruling providence and the like. But there is no evidence of deep religious conviction in anything he ever said or wrote." Washington's religion is quite different from the religion of some of us, but unless I misunderstand both religion and George Washington he had a "very deep religious conviction" which became to him a very present help in time of trouble and to which he turned by instinct

whenever he was in the greatest anxiety. This religious feeling is *not* recorded chiefly in his more formal papers but in his letters to his family and fellow soldiers.

Washington was not at all a puritan and the attempt to make him one has distorted and obscured his figure and personality. His education and experience were very different from those of Oliver Cromwell, but just as strongly as Cromwell, Washington came to feel that God was with him and the cause of liberty—which to him meant that all the good forces of the universe were pledged to him and so his cause could not fail. There does not seem to be any reason to attribute to him the so-called prayers of Washington found one hundred years after his death at Mt. Vernon. The relief showing Washington on his knees seems to me to embody in lasting bronze a myth. There does not seem to be sufficient reason to believe that Washington prayed at that time and place and in that way. But it is a myth which embodies, as myths often do, essential truth. If he did not pray then and there his active fighting life became a prayer—a confession of his belief that God who had helped would help him.

He wrote to his brother after the Battle of Monmouth: "All would have been lost had not that bountiful Providence which has never failed us in the hour of distress, enabled me to form a regiment or two of those who were retreating in the face of the enemy and under their fire."

To Benjamin Harrison he wrote: "Providence has heretofore taken care of us when all other succour seemed to be departing from us." And to General Nelson he wrote: "The hand of Providence is so conspicuous in all this, that he must be an infidel that lacks faith and more than wicked that has no gratitude." He wrote to General Armstrong: "Our affairs are brought to an auful crisis that the hand of Providence may be more conspicuous in our deliverance. The many remarkable interpositions of the Divine Government in the hours of our deepest distress and darkness, have been too luminous to suffer me to doubt the issue of the present contest." If that is not religion then I don't know it when I see

it. Altogether aside from all questions about ecclesiastical establishments, or theological systems or social habits is a phenomenon like this religion of George Washington. It strengthened him to do as hard a task as man has ever done. His reliance in "*Providence*," saved him from despair and failure. That is the best proof of the sincerity and the power of a man's faith in the unseen. For surely if a man's religion carries him through overwhelming tasks, that man's religion is not vain.

The name of Christ occurs only twice in the whole range of Washington's writings. Once when a school boy he copied, apparently as an exercise in penmanship, a theological poem containing many of the doctrines related to the doctrine of the incarnation. Later he does not seem to have had any interest in any theological doctrine. The *deeds* of Christ, yes. Leaving for the army besieging Boston he wrote to his manager at Mt. Vernon: "Let the hospitality of the house with respect to the poor be kept up. Let no one go hungry away." Near the end of his days he wrote to his adopted grandson: "Never let an indigent person ask without receiving something, if you have the means, always recollecting in what light the widow's mite was received."

It was from this point of view that at the close of the war he ended a circular letter to the governors of the several states: "I now make it my earnest prayer that God would most graciously be pleased to dispose us all to do Justice, to love mercy and to demean ourselves with that charity, humility and pacific temper of the mind which were the characteristics of the Divine Author of our blessed religion and without an humble imitation of whose example in these things, we can never hope to be a happy nation."

Another thing necessary if we are to form correct ideas of George Washington's place in our history, or indeed of anybody's place in any history, is to avoid being swept off our feet by new and popular ideas which may carry us to ridiculous extremes. Chance recently put in my hands an excellent example of what I mean. You will all remember that brilliant

and fruitful book published some years ago entitled *The Frontier in American History*, changing some aspects of history, resulting in many useful researches. The other day I bought at a railroad newsstand a popular magazine, because it excited my curiosity by advertizing a life of Sitting Bull. Here is the conclusion to which the unchecked surrender to an imperfectly understood idea, mixed with the effete Europe idea, has led the writer.

"Consider what the history of America would have been had there been no native peoples on this continent when the white man came. Only a dull chronicle of plodding clodhoppers, moving each year a little farther into the vacant wilds, carrying along their imitation European customs and ideas, their outworn European culture, unchanged and unchanging—rubber stamps.

"But, as it was, thank Heaven we had a frontier and, as historians keep telling us, it was this frontier which shaped America, molded a nation unlike any other. That Frontier made America and the Indians made the Frontier.

"Sitting Bull, leader of the largest Indian nation on the continent, was the very heart and soul of that frontier, the strongest, boldest, most stubborn opponent of European influence. When the true history of the American Republic is written, he will receive his chapter. For Sitting Bull was one of the Makers of America." Long ago, we are told, people asked is Saul also among the prophets? Are we expected to ask was Sitting Bull also among the Fathers of the Republic?

Picturesque but untrue anecdotes have done much to obscure the life of Washington. The first of his scholarly biographers wrote within a generation of his death: "I have seen many anecdotes which I knew not to be true and others which I do not believe." But brilliant ideas imperfectly understood, and applied without judgment, are even more dangerous than picturesque anecdotes unsupported by testimony.

At the age of forty-three this woodsman, Indian fighter, land speculator and large planter was suddenly called to

take command of the American Army in fight a which soon became a struggle for independence. The call was sudden. The readiness to answer if the call came was of long standing. Six years before he reluctantly left his beloved Mt. Vernon to take command at Boston, he had written to a friend: "That no man should scruple or hesitate a moment to use arms in defence of so valuable a blessing (as ancestral liberty) on which all the good and evil of life depends, is clearly my opinion. Yet arms should be the last resource."

Washington became indispensable to his cause. If Julius or Augustus Caeser had perished earlier than they did, we can imagine some other great patrician replacing the rotten Roman republic by the long time beneficent Roman Empire. But if Washington had fallen in the Battle of Princeton on the long slope that stretches down from Nassau Hall, who could have replaced him? Was not Lafayette right when he wrote: "No one but you can keep the army together."

Why was he indispensable? Because of a genius for war or a deep knowledge of statecraft? No. When he retired from fighting Indians to his plantation, he wanted as souvenirs of his five years of fighting in the wilderness, the busts of six great generals to put on his mantelpiece. He did not show military brilliance on a par with that of any of them. Napoleon was more brilliant in war and showed more organizing capacity in peace. What was it then that made this ex-Indian fighter and plantation manager, a faithful member of his parish vestry and the House of Burgesses, the one indispensable man?

It was not the brilliance of his qualities. It was the steadfast strength of his character. That shrewd if somewhat sentimental observer, Lafayette, wrote home: "Our general is a man made for this revolution, which could not be accomplished without him. I see him more closely than any man in the world and I see that he is worthy of the adoration of his country. I admire more each day the beauty of his character and of his soul. . . . His name will be revered in all ages by all lovers of liberty and humanity."

What were the qualities which enabled him to stand out against the Crown and Parliament until the French could turn the scale and then, in the building of the Republic, to become the master workman without whose presence it could not have been built?

There were, I think, five fundamental qualites in what Layfayette calls "the beautiful soul of Washington." The first was courage. His officers and men blamed him for taking too many risks, but, in their hearts, they were proud to know that the general could always look death proudly in the eye. At Braddock's defeat he ran his chances in the fearful slaughter of English and Virginian officers who fought like men and died like soldiers when the men in the ranks were helpless in panic, shooting each other and firing their muskets into the air. At Monmouth he saved defeat, at Princeton he turned defeat into victory, for danger was not to Washington a thing to be overcome. It was a stimulant, a strong wine of the spirit. When things were at their worst, he was at his best. But the courage of Washington went deeper and became not simply the winner of battles but the cornerstone of victory. Here is a letter I cite from Prussing. I have seen others of the same tenor from Washington, but none so elequent. "When he was almost at the end of his resources, he wrote: 'Though friends, followers, countrymen should betray or abandon me, I will return to my own Virginia, plant the standard of liberty on my native mountains, and, calling around me the friends of freedom, we will fight for our country and our homes in the enjoyment of our independence and beyond the reach of a tyrant.'"

The second quality of character was good judgment. If you ask me what good judgment is, I cannot tell you and you would probably find it hard to define to your satisfaction, but we know it when we see it and Washington had it. Patrick Henry was asked who was the greatest man at the Continental Congress. He replied that Rutledge of South Carolina was the most eloquent, but for solid information and good judgment Col. Washington is unquestionably the greatest

man on that floor. Later John Adams wrote: "He seeks information from all quarters and judges more independently than any man I ever knew."

A third quality which made his work possible was a power to win the hearts of men. This is a power which cannot be fully explained. Very different men may have it in very high degree. Napoleon had it and so did Francis of Assissi. It does not preclude enemies, for men who have no enemies are sometimes lacking in very warm friends. Washington had enemies, but from the beginning to the end he won the hearts of men. When he was head of the tiny army of Virginia, twenty years before he took command of the Continentals, one of the young officers wrote his uncle: "Our Colonel is an example of fortitude in danger or hardship and by his easy polite behavior has gained not only the regard but the affection of both officers and soldiers." When he retired, as he supposed, from war for good, his officers of the Virginian army signed an address to tell "him how sensibly they are affected with the loss of such an excellent a commander, such a sincere friend, and so affable a companion." When nearly thirty years later he lifted a glass of wine to drink farewell to his officers of the victorious Army of America, it had all the warmth and the affection of a sacramental cup of friendship.

Finally, there was as a characteristic of his personality, magnanimity and a sense of duty. He was in the highest degree magnanimous. He had no ambition except the ambition to serve well. He had no self-seeking except the seeking to realize himself in his duty. Starting as a younger son with very moderate expectations, he was at his death perhaps the richest man in America. He risked his great fortune, to say nothing of his life, in defense of liberty, not because he liked to be a leader, but because he thought he ought. For that risk and danger and for his services he would take no salary, and when the Congress offered to increase hugely his acres of fertile wild lands, he refused to accept it, although his wife's fortune was largely lost by depreciation of the currency which permitted repayment of loans enormously below their value—although in his absence his plantations

were run down and not very productive—though he was land poor and often hard up for cash. He had everything to lose and nothing to gain. He would much sooner farm than mount the Commander's horse or sit in the President's chair. He would much sooner have spent those twenty-five years at Mt. Vernon with long trips through the colonies, than be the most conspicuous man in America. When some of his officers wanted to make him King, Washington was hurt and angered that they should suppose him capable of such a betrayal.

He was pleased by affection but greatness was burdensome to him. Unfortunately the correspondence between Washington and his wife has largely perished but one of the few significant letters which have survived is explicit and revealing of the *magnanimous* mind of Washington. Martha writes to her friend Mercy Warren: "When the war ended, I had anticipated that from that moment we should be suffered to grow old together in tranquillity. But though his feelings and my own were in perfect union with respect to our predilection for private life, yet I cannot blame him for having acted according to his ideas of duty in obeying the voice of his country. He acted from what he conceived to be a sense of indispensable duty." This letter is confirmed by a few lines of a letter written about the same time by Martha to her nephew John Dandridge; now in your collections in this building. "I am truly sorry to tell you that the general is gone to New York. When or whether he will ever come back again God only knows. I think it was much too late for him to go into public life again but it was not to be avoided." Those few lines of his wife are the best short sketch of George Washington. It was not great capacities that made him the successful leader of his people. He was to an extent that perhaps no other hero of any nation has been brave, judicious, loyalty inspiring, absorbed by duty, magnanimously indifferent to his own danger or his fame. The extraordinary thing about him is not the soldier or the president, but Washington the man. Of all the heroes of the nations he was the most human.

THE HUMANISM OF CICERO

By E. K. RAND

(*Read April 22, 1932*)

DURING the last decade, the banner of Humanism has been flung with a new confidence to the breezes and the little host enlisted in its name have marched with a new determination against the foe. The new battle of the books ranges widely over the field of literature, ethics, philosophy and theology. It differs from that of the days of Swift which, involved primarily in a *querelle des anciens et des modernes*, was fought unambiguously on a vertical, a chronological, plane. The battle-ground of our new *Psychomachia* is horizontal and contemporary, with diverse wars and diverse warriors. It must be hard, moreover, for an impartial observer whose interests lie elsewhere than in the so-called humanistic studies, to be sure who is on the side of the angels, who is on the diabolic side, and what, after all, the conflict is about.

Who are the humanists? My friends Irving Babbitt and Paul Elmer More are obviously of the number. Norman Foerster has gathered in a volume entitled *Humanism and America* [1] a number of entertaining essays by them and by others of the school. The best paper in this book is, in my opinion, that by Mr. Babbitt himself; in it he essays a definition of humanism, at the heart of which lies the principle of balance and self-control. Not all the contributors agree at all points. The churchmanship of Mr. T. S. Eliot, for instance, is not that of Mr. Babbitt. But, somewhat like the members of Mr. Wickersham's commission on the enforcement of law, these humanists can preserve their individual differences while voting for a general declaration.

From the other side, an answer, or rather a set of answers, has been given in a volume assembled by Mr. C. H. Grattan.

[1] New York, Farrar and Rhinehart 1930.

Though the work is entitled "The Critique of Humanism," it is flavored with the philosophy of Professor Dewey, one of the founders of the school of pragmatism, which Mr. Schiller of Oxford certainly identifies with humanism and which traces its lineage back to Protagoras, the arch-humanist of antiquity. "Man is the measure of all things"—πάντων χρημάτων μέτρον ἄνθρωπος. What could be more humanistic than that?

The humanists are, in general, conservatives, staunch champions of tradition. But so is, for example, Mr. Canby, who in his *Saturday Review* has voiced his opposition to the tenets of Babbitt and More, while on local ground, Mr. Babbitt has more than once tilted a lance against John Livingston Lowes; yet nobody in our generation has excelled Mr. Lowes in his sympathetic and judicious treatment of the old as well as the new—or what he calls convention and revolt—in poetry. One might gather that modern science finds little favor with humanists—though they are careful to distinguish science from pseudo-science—and yet a scientist of note has joined their ranks. Mr. Julian Huxley pleads for a humanism that aims, in sympathy with the teaching of our Lord, "to have life and to have it more abundantly"; he would like to gather all humanists into a kind of church.[1] But this church would be of the sect called "broad"; its tenets might not find favor with the sterner humanistic defenders of the faith once delivered to the saints.

To match this eminent accession, we note an eminent defection. Miss Rebecca West, for some time correspondent of the *Bookman*, announces her regretful farewell after reading certain maledictions that in the name of humanism had been made there.[2] The ardor of the contestants, so I have been informed, has even come to blows, or the prospect of blows, when a spirited antihumanist of the South sought out a satirical humanist of the North, to make him eat his words on the field of honor. It is a perplexing conflict. One who began

[1] "Human Power and its Control," *The Yale Review*, June, 1931, pp. 649–662.
[2] *Ending in Earnest*, 1931, p. 281.

repentantly with the cry, "What must I do to be humanized?" is now reduced to two inquiries, first, "Who is, then, a humanist?" and second, "Who, then, is not?" All of the contestants, I feel sure, have received a liberal education, all display an intelligent fondness for letters and high thought, and in many cases they possess a national or an international reputation in the subjects that they profess. Oh *cives, cives!*

> "Can heav'nly minds such high resentment show?"
> *Tantæne animis cælestibus iræ?*

Meantime, while the smoke of battle all the valley fills, Mr. Santayana looks down from his eternal sunshine as calmly as Virgil's farmer watched the warfare of his bees. In a triple broadside in the *Saturday Review of Literature*, called "The Genteel Tradition at Bay"[1] he analyzes the strife over humanism in America, advises our humanists to bulwark their tenets with a revealed and supernatural code, and for his own part proposes a humanism that is at once spiritual and naturalistic. Not all of us can understand Mr. Santayana; all will admire the grace of his style and the neatness of his wit; and some may suspect that there is, specially designed for them, a sting in his argument's supple tail.

It is beyond my desire, my skill, and my time to propose a pacific formula that will end this acrid war. Instead, I would call my hearers back into the quiet past, which, though the same conflicts were stirring then, we may observe quietly *sub specie æternitatis*. We will not linger in the Renaissance, though humanism was the shibboleth of its culture. We should find widely divergent types in the humanism of a Boccaccio, a Filelfo, a Sannazaro, a Politian. We should find then as now a tolerable command of humanistic billingsgate. We should find among us moderns widely divergent interpretations of those spatious times. To Walter Pater the soul of the period is mirrored in Pico della Mirandola, who saw antiquity through the mystic haze of Plotinus. To Mr. Santayana, the Renaissance, for all its achievements in

[1] Jan. 3, 10, 17, 1931, pp. 502–3, 518–19, 534–35.

scholarship and poetry was "a great surrender of the spirit to the flesh"; its true heirs today are, as he puts it, rather the naturalistic philosophers of the extreme Left than the academic people who still read, or pretend to read, the classics. Nor will we contemplate the Christian humanism of the Middle Ages, though sorely allured by a *vox de profundis* from Ernst Robert Curtius who in his recent book *Deutscher Geist in Gefahr* regards the foundation of the Mediæval Academy of America as an omen of hope and the return to mediæval ideas as the last resort for humanists in an age when the star of Hellenism has set beyond recall. Nor have we a moment, even though we are mediævally inclined, for the great fourth century, when the principles of Christian humanism were established for the centuries to come. Instead, we will abandon the rivulets for the fountain-head and fix our attention on Cicero, the man who, so far as the records of literature allow us to see, first discussed and consciously portrayed the ideal that he called *humanitas* and who was the very type of that ideal for Lactantius and St. Jerome in the fourth century, for Bernard of Chartres and John of Salisbury in the twelfth, and for Petrarch and Poggio, for Bembo and Erasmus in the new humanism of the Renaissance.

We may start with one of the lucubrations of Aulus Gellius [1] of whom at last we have a good rendering into English prose by one of your distinguished members [2] and who tells us that although in his time, the second century of our era, the word *humanitas* was popularly identified with φιλανθρωπία or benevolence, its real meaning could be found in almost any of the works of Varro or Cicero. They used it, he said, to signify a training in the 'good arts,' *artes bonæ*. To any reader of Cicero today, that is plain enough. These good, or liberal, arts, the arts befitting a gentleman, *homo liberalis*, included, in an informal fashion, the seven branches of the later *trivium* (*grammatica*, *rhetorica*, *dialectica*) and *quadrivium* (arithmetic, geometry, music, astronomy), and something

[1] *Noctes Atticæ*, xiii, 7.
[2] J. C. Rolfe, in the Loeb Series of the Classics.

more. He names as the arts whereby the training of a gentleman is effected (*doctrinæ liberales et ingenuæ*) geometry, music, the study of literature both prose and poetry, the natural sciences (*quæ de naturis rerum dicerentur*), those that pertain to human character and customs (ethics, that is, and, incipiently, economics and sociology) and those that pertain to public affairs (history and government).[1] Arithmetic is not named, but it is presupposed. So, among other investigations of nature, is astronomy, to which Cicero devotes plentiful attention elsewhere.[2] *Grammatica* also is not mentioned here, but it is in another passage[3] where it is said to comprise a study of the poets, a knowledge of history, an interpretation of words, and the art of pronunciation, or reading aloud.

That the love of good books is essential to true culture as Cicero conceives it, is obvious not only from the explicit statement to which I have referred, but from that famous encomium of literature in the oration in behalf of Archias,[4] a passage which we read, or construe, as school-boys, but the truth of which comes to us, as the truth of Homer and of Horace came to Cardinal Newman, after the deepening experience of years. It is the passage that late Senator Lodge, an ardent friend of the Classics, quoted in the original at the opening of the Widener Library at Harvard. He apologized for quoting it in the original, and added that he would have apologized for so quoting it thirty years before, but for a different reason—then because it would have been too trite, now because none would understand it.

Such, then, was the training whereby the young, to quote from the *Archias* again[5] are 'moulded into humanism'—*artibus quibus ætas puerilis ad humanitatem informari solet*—or, let us translate it in a simpler way, 'learn how to become human.' The crown of it all was philosophy, which to Cicero

[1] *De Oratore*, iii, 127.
[2] *E.g.*, in the first book of the *Tusculan Disputations* and in the *Dream of Scipio*.
[3] *De Oratore*, i, 187.
[4] 16.
[5] 4.

as to his master Plato, was the queen of the sciences and the arts.[1]

What means philosophy? When we hear from various modern writers that philosophy was for Cicero a kind of consolation-literature, inspired by the death of his daughter Tullia, we should recall his own statement that from his youth up his mind had been occupied with the basic problems of thought;[2] we should give heed to his definition of the philosopher as one who seeks to know the essence, the development and the causes of all things human and divine—science and theology, that is—and to comprehend and to practise the art of right living—ethics as a theoretical system and ethics as a guide for life.[3]

The words *humanus* and *humanitas* are spread plentifully on the pages of Cicero. They have been studied by various scholars, most carefully by Reitzenstein.[4] To Cicero, clearly, the adjective *humanus* connotes not so much 'humane'—though this idea is included too—as 'humanized,' 'civilized.' *Humanitas* is the quality that one acquires in the process of developing the best that there is in human nature. A man thus humanized will be the opposite of 'wild,' 'brutal,' 'bestial.' He will be mild, gentle, merciful, compassionate, benevolent. He will be loyal to duty, upright, virtuous. He will have the social graces, possessing tact, courtesy, forebearance of others, *savoir faire*. In a group of cultivated people he will contribute his share to the conversation, master of the ready word, of wit, of banter, of urbanity. These diverse accomplishments, and others related to them, are exhibited by the contexts in which Cicero has set the word *humanus* or by the adjective with which it is paired. In contrast with the *homo ferus*, 'the wild man,' they present a mirror of the gentle-man.

[1] *Tusc.* i, 1, 64.

[2] *Tusc.* i, 1; *Acad.* i, 11.

[3] *De Or.* i, 212: Philosophi denique ipsius, qui de sua vi ac sapientia unus omnia pæne profitetur, est tamen quædam descriptio ut is, qui studeat omnium rerum divinarum atque humanarum vim, naturam causasque nosse et omnem bene vivendi rationem tenere et persequi nomine hoc appelletur.

[4] *Werden und Wesen der Humanitat im Altertum*, Strassburg, 1907.

But this is not all. If it were, the humanism portrayed by Cicero, for all its polite graces, would be self-centred. His repeated commendation of the Delphic utterance 'Know Thyself' is accompanied by the explanation that the self we are to know is not the body but the soul, which is immortal and akin to the *summus deus* who made and rules the universe. Humanism, that is, not only may be reconciled with religion, but needs religion for its existence. The humanist will not dwell in his own perfection or in the pleasant society of this friends, but will make his soul immortal by reverencing the power supreme and by devoting his life to the state.

To Reitzenstein, Cicero's adaptation of religion to humanism is a falling-away from grace. The real humanism he finds in the so-called Scipionic circle of the century preceding Cicero, of which the guide and master was the Greek philosopher Panætius. Panætius taught a humanism that wisely kept to the plane of earth; Cicero, corrupted by the vague mysticism that came to Rome from the East, perverted this pure culture with an admixture of the other world.

But really, we do not know just what Panætius taught. His is a name to conjure with, like that of Posidonius. His works are those which we ourselves to our own enlightenment reconstruct and of which we then with our own powers trace the consequences. It happens that Cicero himself has pictured this Scipionic circle in action. In that great work of his on the *State*—which might prove perhaps his greatest did we have it entire—it is the younger Scipio who delivers the main argument, and Lælius and his friends who listen or discuss, and to these founders of the ideal state, religion is solidly built in its foundations. I venture to surmise that Cicero knew more of the ideas of Panætius than Reitzenstein does and that the argument of the *De Republica* may not be discordant with them. In one respect it differs. It leads to the discussion of the statesman's reward, which is pictured in the *Dream of Scipio* at the end of the talk. In this piece of musical and majestic prose, which is the only bit of *De Republica* that thanks to fate and the commentary of Mac-

robius has been preserved entire, Cicero, following in Plato's wake, with a different purpose and a different myth, sets forth the life immortal as the statesman's prize. But though Panætius deserts his worshipped Plato at this point, we may not infer, I believe, that in excluding immortality he banned religion with it.

For a model of urbane culture, for a programme of liberal education as the necessary precursor of a stateman's career, for a pleasant picture of courteous debate among men of opposing views—a scene that makes our present war of words look like the bickerings of a political convention— we might turn to the *De Oratore*, a standard document in the history of humanism and a *vade mecum* for that mirror of the gentleman, the *Cortegiano* of Castiglione. The works of the *State* and on the *Laws* are even more valuable for the humanist's contemplation. They present what Cicero deems the true nature of man in its application to his life in the community of which he finds himself a part.

More valuable for our present purposes than a pound of analysis is an ounce of quotation. I can only recommend a perusal of both these works and a comparison of them with Plato's teachings in his *Republic* and his *Laws*—yes, and with Mr. Santayana's naturalistic humanism, which nevertheless finds a place for the spiritual realm as man's natural domain and for a vision of ecstasy. He can write:

> "In raising truth to intuition of truth, in surveying the forms and places of many things at once and conceiving their movement, the intellect performs the most vital of possible acts, locks flying existence, as it were, in its arms, and stands, all eyes and breathless, at the top of life.
>
> "Reason may thus lend itself to sublimation into a sort of virtual omniscience or divine ecstasy: yet even then reason remains a harmony of material functions spiritually realized, as in Aristotle the life of God realizes spiritually the harmonious revolutions of the heavens."

What boots it whether we call such a humanism natural or supernatural, if these are the heights to which it leads? I might match this passage with one in the *Tusculan Disputa-*

tions,[1] a beatific vision of man's growth in knowledge and in the pleasure of knowing gained in the life to come. Instead I select something of the sort from Cicero's examination in the *De Legibus* of the basic principles on which the idea of law reposes.[2] After exalting the life of reason which distinguishes a man from a beast,[3] and the unbounded life in which as for the poet nothing that is human is alien to him,[4] and the unselfish life wherein a man accomplishes that incredible thing, to love his neighbor as himself,[5] Cicero can write: [6]

"For he who, following the Delphic precept, knows himself, will see first of all that there is something of the divine within him, and he will do something worthy of the great gift of the gods. He will understand in what way he has come into life endowed by nature and what instruments he has for acquiring wisdom. He will see that he is not bounded by the walls of some particular place, but is a citizen of the whole world as though it were a single city. Aye, in this magnificient realm and in the sight and contemplation of nature, then will he know himself! He will build about him a sure wall by the exercise of reason, by the science of judging the true and the false, by the art of understanding consequences and contradictions. Thus, when he perceives that he is born for civic society, he will have recourse not merely to subtle disputation but to those broadly applied and permanent principles by which he shall rule nations, establish laws, chastise the wicked, protect the good, praise the eminent, console the afflicted and to the shame of the wicked transmit on imperishable monuments the tenets of the brave and the wise. These are great untertakings. That the capacity for achieving them is recognized by those who know themselves is the work of its author and inspirer philosophy."

Truly, for Cicero no less than for Dante, the teaching of

[1] i, 44–45
[2] *De Legibus*, i. 59–61
[3] *De Legibus*, i. 22–23
[4] i, 33
[5] i. 34.
[6] I select parts of noble passage, all of it significant, i, 58–60

philosophy is *come l'uom se 'eterna.* Here from his lips is a creed for humanists, if humanists must have a creed; here at any rate are guiding principles for those who with Cicero would seek and find that which is most human. Instead of framing little categories and, now that inquisitional faggots are no longer fashionable, blasting the uncategorized in ill-tempered debates, I would suggest that, whether we be known as humanists, semi-humanists, quarter-humanists, or anti-humanists, we declare a truce of a year, to be spent in reading the works of Cicero. We may learn from him at every turn how the cult of ancient precepts may help and not hinder the human spirit in fashioning the new. It is better to enlarge our sympathies, if we keep them in control, than to exercise a theoretical principle of control that stifles our enlargement. Humanists should pass on to fresh runners in the race a torch not quenched but shining with new fire.

FRANKLIN—POLITICAL PHILOSOPHER

By JAMES BROWN SCOTT

(Presented at the Annual Dinner, April 23, 1932)

MR. PRESIDENT, LADIES AND GENTLEMEN,

THE 23d day of April is no ordinary date, for it is connected in a twofold manner with the poet of the English-speaking world, and it is inextricably associated with the master of Spanish prose. Our Shakespeare was born on the 23d day of April, 1564, and he of England and Cervantes of Spain died on the same 23d of April, 1616. Between the birthday on the first 23d and the double loss to the world on the second 23d, the poetry and the prose of the modern world have run their course.

We of the English tongue commemorate the birth of Shakespeare as if it were the inheritance of our race, and the Spaniards of Spain and of its spiritual empire beyond the seas observe the 23d day of April, the date of Cervantes' passing, as the *Dia de Cervantes*, which is in very truth the *Dia de la Raza.*

Today the American Philosophical Society for Promoting Useful Knowledge celebrates Founder's Day; and it is impossible to speak of Founder's Day without having in mind the founder, Benjamin Franklin, himself in his many-sidedness a worthy companion of Shakespeare and of Cervantes in the short and select list of the world's immortals.

Doubtless there has been a toast on every Founder's Day to the memory of Franklin. Which Franklin? For it is wellnigh impossible within the limitation of time even to enumerate the many sides of this amazing man. It is even impossible to dwell at adequate length upon any one phase. The most that can be done is to show his relation to it.

The phase which occurs to me, and of which I can not rid

myself, is that of Franklin the political philosopher. In a letter to his son William, loyalist Governor of the Colony of New Jersey, written on the 6th of October, 1773, from London, where Franklin the father was representing Pennsylvania and also as a sort of Envoy Extraordinary and Minister Plenipotentiary of the English-speaking Colonies of America, he said:

> From a long and thorough consideration of the subject, I am indeed of opinion, that the parliament has no right to make any law whatever, binding on the colonies; that the king, and not the king, lords, and commons collectively, is their sovereign; and that the king, with their respective parliaments, is their only legislator.

The relationship of the Colonies to the Mother Country was a theme upon which he abounded. Some five years earlier he had written to the same correspondent: "The more I have thought and read on the subject, the more I find myself confirmed in opinion that no middle doctrine can be well maintained. . . . Something might be made of either of the extremes: that Parliament has a power to make *all laws* for us, or that it has a power to make *no laws* for us." His preference was for the latter, the result of whose acceptance would be "so many separate states, only subject to the same king. . . ."

To these letters and their international implications I would invite your attention, presuming that even the "many-sided" Benjamin would doubtless have been "amazed" if, in his lifetime, it had been whispered that his views were to be realized by posterity in the four quarters of the globe, and, as set forth in the Statute of Westminster, to go into effect December 1, 1931, to receive the royal assent of His Majesty King George Vth on the 11th of December of that eventful year.

The purpose of the Statute of Westminster was to put into effect the declarations and resolutions of the two Imperial Conferences of 1926 and 1930, in which took part delegates of the United Kingdom of Great Britain, the Dominion of Can-

ada, the Commonwealth of Australia, the Dominion of New Zealand, the Union of South Africa, the Irish Free State and Newfoundland; and the effect of the statute was and is to put upon a footing of equality the self-governing dominions, including the United Kingdom itself. Each is thus independent of the other, as acknowledged by an alliance of all, with a dependence upon a common sovereign, who ceased to be King of Britain only in order to become the sovereign of each of the dominions forming the British Commonwealth of Nations,—a new constellation in the political firmament that would have made our Franklin—instead of Quintilian—"stare and gasp."

Each of the erstwhile Colonies, recognized as nations by the Statute of Westminster, was already self-governing, in so far as its internal affairs were concerned. The Crown, however, possessed the right to veto their laws, the exercise of which right was annoying to the Colonies and distasteful to the mother country.

A step toward equality in their international relations was taken in 1908 in the Treaty of Arbitration between Great Britain and the United States, with a proviso that a dispute was only to be submitted by Great Britain to arbitration, with the previous consent of the self-governing Dominion whose interests should be involved.

A further step—which indeed recognized in law as well as in fact their international personality—was taken in 1919, when the present self-governing Dominions—with the exception of Ireland and Newfoundland—were signatories to the Treaty of Versailles, and, as contracting parties, members of the League of Nations in their own right, with representatives in the Assembly, on a footing of equality with all other members, with the right of election to the Council and the prospect of judges of the self-governing Dominions in the Permanent Court of International Justice.

To use a catchword of our day, both the law and practice were ripe for codification, and the Statute of Westminster codified and legalized the existing situation.

A delegate of one of the Dominions has been president

of the Assembly of the League of Nations, and another a member of the Council, although the international court at The Hague is still awaiting a member other than from the United Kingdom.

But to the Statute of Westminster.

The status of the Crown should be first considered, as the Crown is the bond of union, its wearer being equally the sovereign of each of the equal nations forming the British Commonwealth.

The language of the statute is: "The Crown is the symbol of the free association of the members of the British Commonwealth of Nations, . . . united by a common allegiance to the Crown." From this the conclusion should be—and it is so drawn in the statute—that "any alteration in the law touching the Succession to the Throne or the Royal Style and Titles" would necessarily require in the future "the assent as well of the Parliaments of all the Dominions as of the Parliament of the United Kingdom."

Here we have Franklin's Parliaments not merely in being but in action.

Given this state of affairs, it was but natural that a future act of the Parliament of the United Kingdom should not affect a Dominion, without its consent, any more than an act of a Dominion should affect the United Kingdom without its consent; and also that each Dominion should possess the power to repeal its acts in the same manner as the Parliament of the United Kingdom would have to repeal its own. Acts of the United Kingdom and of each of the Dominions are thus to be equally binding within their respective spheres, and each act is to have, under the law of nations, extraterritorial effect.

Such are some of the terms of the Statute of Westminster implicit in Franklin's conception of the relationship of the thirteen English-speaking Colonies to the United Kingdom of Great Britain and Ireland of his day.

Just as George III was King of Great Britain and of the Kingdom of Hanover, so is his descendant, George Vth, King of each of the Dominions forming the British Commonwealth

of Nations. Residing as he does in London, he confers directly with the Prime Minister of Great Britain. But as there is an inexorable law—which not even Franklin could change—that no person—though he wear a Crown—can be present in different capitals at one and the same time, the King of each of the Dominions must act through a representative residing in the capital of each, in order to exercise the administrative functions of the sovereign of each. These representatives are Governors General appointed by the King, upon the recommendation of the Prime Ministers of the respective members of the British Commonwealth of Nations.

So much for the internal machinery of the "free association."

In matters international, each of the Dominions will, as an independent nation, have the right to be represented by diplomatic agents at each capital of the other independent nations of the world. Like the Governors General, they will be recommended by the Prime Ministers of the respective Dominions which may desire diplomatic representation. At present there are Ministers Plenipotentiary and Envoys Extraordinary of the Dominion of Canada, the Irish Free State and the Union of South Africa accredited to the President of the United States.

There remains a slight difficulty,—too small, perhaps, to be mentioned, but of more than passing interest—that the Great Seal—affixed to documents of "great" importance—resides, like the King, in England, but in the custody of a responsible Minister, to be affixed only by his authority. Recently a Great Seal has been made for the Irish Free State; and a Great Seal similar to that in London is likely to migrate to the capitals of each of the other nations forming the British Commonwealth.

It will undoubtedly be the desire of the sovereign of each of the British Dominions that treaties with various "foreign" nations shall be identical—in so far as the common interests of the Commonwealth are concerned,—although in such a

case it would be necessary that plenipotentiaries recommended by the Prime Minister of each Dominion should be appointed by the Sovereign or by the Governor-General, with the Sovereign's approval, to conclude its international agreements.

The foreign affairs of the Dominions are to be in their own keeping.

There is still a matter outstanding, of which a word should be said—and more than a word is being said at the present time—that each of the Dominions owes allegiance to the individual sovereign, who by the Statute of Westminster is the duly constituted and common sovereign of the British Commonwealth of Nations.

Independent in fact, they may one day wish to appear to be independent in form.

In a letter to Richard Price, under date of February 6th, 1780, written from Passy while the war with the mother country was still in progress, Franklin said: "We make daily great Improvements in *Natural*, there is one I wish to see in *Moral* Philosophy; the Discovery of a Plan, that would induce & oblige Nations to settle their Disputes without first Cutting one another's Throats. . . . When will Men be convinc'd, that even successful Wars at length become Misfortunes. . . ." The discovery of the "plan" has not been made, but the enlightened of all the world fortunately share Franklin's belief in a moral philosophy.

Sir Samuel Romilly, who had availed himself as a young man of the opportunity of a word with Franklin at Paris within a month after the signature of the treaty with Great Britain recognizing the independence of the United States, records the venerable statesman as saying that a limitation of armament was possible—and only possible—by a treaty in which the contracting powers would consent to reduce their armaments; for if any one power should venture to do so alone, it would be overrun by its neighbors.

In the present year and at this very time this question, in accordance with Franklin's view, is being debated at Geneva.

Sir Samuel Romilly's opinion later in life, when he had met many of the world's elect, was that Franklin remained the greatest; indeed that "he was one of the most extraordinary men that ever existed."

Talleyrand, who had had large and varied experience with men of affairs, thought that the great men whom he had known in Europe were Napoleon and Charles James Fox, but that Alexander Hamilton, whom in exile he had met in Philadelphia, was greater than these because he had divined Europe. What would Talleyrand have said had he known our Franklin, who, we might say, had prophesied the British Commonwealth of Nations?

Only the prophecies of those who deal in fundamentals come true.

Would it not be singularly appropriate should there be established a Benjamin Franklin fund for equality of right in all our national and international relations?

There have been so many strange happenings—miracles, we may say—under our very eyes, that it would astonish us less than Franklin, if the memory of the founder of the American Philosophical Society for Promoting Useful Knowledge should one day be celebrated not merely in the City of Philadelphia, but also in the capital of every member of the British Commonwealth of Nations.

Mr. President, Ladies and Gentlemen: I raise my glass to Benjamin Franklin, Founder and Political Philosopher.

LOWER DEVONIAN FISHES OF BEAR TOOTH BUTTE, WYOMING

By WILLIAM L. BRYANT

(*Read by title, April 22, 1932*)

INTRODUCTION

IN 1928, geological students from the University of Missouri made an important discovery of ancient fossil vertebrates in the lower measures of the Jefferson dolomite on Blacksmith Fork, Bear River Range, about 12 miles southeast of Logan, Utah. This find was announced by Professor E. B. Branson at the 1929 meeting of the Geological Society of America,[1] and in 1931 Drs. Branson and Mehl published a preliminary description of the fauna.[2]

The specimens on which the following paper is based were collected in connection with the Princeton Research Project in the Bear Tooth Mountains of Montana and Wyoming, under the direction of Professor W. T. Thom, Jr. of Princeton University. During the summer of 1931, a party of investigators consisting of Professors R. T. Chamberlin of the University of Chicago, W. H. Bucher of the University of Cincinnati, E. L. Perry of Williams College, E. Dorf of Princeton University and Mr. R. F. Miller of Massachusetts Institute of Technology, made a reconnaissance trip into the Bear Tooth Mountains, across the Wyoming line, to Bear Tooth Butte. In the descent from the summit of the butte, fish plates were discovered and collected from the talus of shaly limestone.

For the following stratigraphic data I am indebted to Dr. Dorf: Bear Tooth Butte is located in the northern part of

[1] E. B. Branson, "New Localities for Devonian Fishes," *Bull. Geo. Soc. Amer.*, Vol. XL, 1929, p. 245.

[2] E. B. Branson and M. G. Mehl, "Fishes of the Jefferson Formation of Utah," *Journal of Geology*, Vol. XXXIX, 1931, p. 509.

OFFICE OF THE DIRECTOR GENERAL ... Library Regr No 45070 ... INDIA

Park County, Wyoming, less than five miles from the southern boundary of Montana. The butte is an outlier of lower Palæozoic sediments resting on a complex of pre-Cambrian granites and gneisses. A preliminary study indicates that the twelve-hundred-foot section exposed on the eastern scarp of the butte, above Bear Tooth Lake, consists of Cambrian quartzite, shale, limestone and flat-pebble conglomerate, Ordovician dolomite and Devonian limestone. In the central portion of the scarp face there is a striking lens of shaly red, gray and yellow limestone, lying unconformably above the Ordovician dolomite and below the typical chocolate-colored Devonian limestone. The lens is approximately 150 feet thick in its central portion and disappears completely, northward and southward, less than 500 yards from its center. It penetrates the mass of the butte, emerging on the opposite side, and appears to be the cross-section of a channel-filling. It is from the talus below the lens that the fish remains described and illustrated herewith were collected, but similar material was discovered in place in the lens, later in the summer of 1931, by Dr. Dorf and a party of students from Princeton University.

Plans are in process of elaboration for a further study of the locality and more extensive collecting during the summer of 1932. Professors Bucher and Chamberlin, in order that further study might be facilitated by concentration of type material, kindly relinquished, in favor of Princeton University, all claim to those parts of the 1931 collection secured by them which might contain either types or figured specimens. Extensive use of this material has been made and grateful acknowledgment of the courtesy is herewith tendered.

The collections made at Bear Tooth Butte have been transmitted to me for study. I find that the vertebrate fauna is closely allied to, but in only one instance identical with, that described from the lowest part of the Jefferson formation of Utah. I further consider the Bear Tooth Butte beds to be of about the same age as the lower dolomite fish beds of Blacksmith Fork, Utah, and that the collections made

from each reveal only a part of a large and important vertebrate fauna which lived simultaneously in the waters of these regions.

Age of the Fish Beds

The age of the rocks involved in the fish-bearing beds has been in some doubt. Accordingly, these fossils are of especial interest to the geologist as well as to the zoologist. Before proceeding to a description of the new forms, I shall list the species so far found at the Wyoming and Utah localities above referred to, and consider the evidence they offer as to the age of the rocks in which they are contained.

Bear Tooth Butte Beds	Blacksmith Fork Beds
Class Ostracodermi	
Family Pteraspidæ	
Pteraspis bucheri n. sp.	
Pteraspis dorfi n. sp.	*Glossoidaspis giganteus* B. & M.
Cardipeltis wallacii B. & M.	*Cardipeltis wallacii*, B. & M.
Cyrtaspis ovatus n. gen. & sp.	
Class Pisces	
Family Acanthaspida	
Euryaspis brachycephalus n. gen. & sp.	
Svalbardaspis montanus n. sp.	*Camptaspis utahensis* B. & M.
Gen. & sp. indt. cf. *Arctaspis*	
Family Coccostidæ	
Coccosteus chamberlini n. sp.	*Dinichthys jeffersonensis* B. & M.
	Aspidichthys sp.
Family Ptyctodontidæ	
	Ptyctodus calceoleus N. & W.
Ichthyodorulites	
Onchus penetrans n. sp.	
Bulbocanthus rugosus n. gen. & sp.	
Family Dipteridæ	
Dipterus sp.	

It appears from the above lists that, while five species of Ostracoderms are present, they all may be referred to a single family, the *Pteraspidæ*. There are no representatives of the *Osteostraci* such as the wide-ranging *Cephalaspis* or of the *Anaspida* which we might expect to find were we dealing with deposits of Upper Silurian age.

While the *Pteraspidæ* originated in the Silurian, those early members of the family were small forms with entire or only partially subdivided dorsal shields whose basal layers were sufficiently developed and imbedded to receive the impressions of internal organs. As the *Pteraspids* ranged upwards into the Devonian they increased in size and their armor became comparatively thinner at least in the visceral portion, no longer showing impressions of the soft parts. The order *Heterostraci* to which this family belongs passed away in Upper Devonian times with forms exhibiting the gigantism of senility.

Two of the species above listed belong in the type genus *Pteraspis*, known only from the Downtonian and Lower Devonian. Also, I can see no definite characters that would separate the fragmentary *Glossoidaspis giganteus* B. & M. from the former genus. *Cardipeltis wallacii* and *Cyrtaspis ovatus* agree with the Silurian *Palæaspis* in that the dorsal shield appears to be composed of a single plate in which the orbits form lateral, unenclosed notches. In other respects they differ from the more primitive Silurian forms and take on some of the characters of the Devonian group. All of these American *Pteraspids* are much larger than their European relatives and, in at least two of them, the body behind the bony carapace is scaled.

Associated with the above mentioned *Pteraspids* we find four species belonging in the little known family *Acanthaspidæ*. This peculiar association seems to have its closest parallel in the Lower Devonian of Spitzbergen, where also there has been found a large and curious assemblage of *Pteraspids* and *Acanthaspids*.

If my interpretation of the American fossils is correct,

several of the Spitzbergen genera also occur at Bear Tooth Butte. But among the American *Acanthaspida* are two genera, *Camptaspis* and *Euryaspis* which, each in its own way, differ widely in the character of the trunk armor from any known forms, thus indicating that the classification of these fishes proposed by Anatol Heintz [1] must be radically revised.

Among other fishes represented in the western beds, *Svalbardaspis montanus*, *Coccosteus chamberlini*, and the little known Ichthyodorulite *Onchus penetrans*, are paralleled by species from the Lower Devonian of Europe although only the first genus is strictly confined to Lower Devonian beds.

As for the genera *Dinichthys* and *Ptyctodus* reported by Drs. Branson and Mehl from the Jefferson formation, these remains, which doubtless are of middle or Upper Devonian age, are said to have been found in beds from one to two hundred feet above the horizon at which the other fish fossils occur.

There remain the fragmentary plates referred by Drs. Branson and Mehl to *Aspidichthys*, a Middle and Upper Devonian genus. It is known in America by detached plates of two species with like ornamentation, but very different in size. The type species, *A. clavatus*, Newberry, is known by a large but imperfect dorsal shield of peculiar shape. Newberry was inclined to consider it as a fragment of a gigantic *Pterichthyd*, but it is now generally thought to represent an *Arthrodire*. The second species, *A. notabilis*, Whiteaves, is known by a number of detached plates. These include a left post-orbital plate of the head-roof, an antero-ventro-lateral, and several examples of the antero- and postero-ventro-medians. All of these bones are typically *Dinichthyd* in character and show no resemblance to the comparable bones in the *Acanthaspida*. There is no indication of a fixed spinous appendage on the antero-ventro-lateral and the ventro-median plates were very wide. They completely separated the antero-ventro-laterals. Also the rear end of the antero-

[1] Anatol Heintz. Die Downtonischen und Devonischen Vertebraten von Spitsbergen. Part II. Acanthaspida: *Kong. Dept. Handel, Sjofart, Industri, Handverk og Fiskeri· Skrifter om Svalbard og Ishavet*, Oslo, 1929, No. 22, p. 24.

ventro-median fitted into a socket on the forward end of the postero-ventro-median. This is a specialized character, found for example in *Dinichthys intermedius*.

In a former publication [1] Dr. Hussakof and I compared the tubercular ornamentation of *Aspidichthys* with *Trachosteus* and with *Glyptaspis*. We found that in neither species of *Aspidichthys* do the tubercles ever coalesce or run into lines, but on the contrary they always remain discrete.

In view of the foregoing it is my opinion that the plate referred to *Aspidichthys* by Drs. Branson and Mehl, which plate is covered with tubercles that coalesce in places to form nodose ridges, and which shows evidence of having been attached to a fixed spine, does not belong in the Middle and Upper Devonian genus *Aspidichthys*. It seems rather to belong to some *Acanthaspid*, several Lower Devonian species of which family are known to have confluent tubercles with a linear arrangement.

I conclude from all evidence so far as it has yet come to hand that the fauna of the Bear Tooth Butte of Wyoming and of the lowermost fossiliferous dolomite beds of the Jefferson formation at Blacksmith Fork, Utah is of Lower Devonian age.

Condition of the Fossils

With few exceptions the fish fossils of Bear Tooth Butte consist of detached shields, plates and scales indicating that the soft parts had decayed before fossilization. Often we find only an impression of the fossil left in the matrix, the actual bone having been partly or entirely dissolved by the elements.

On one slab, not far behind the head roof of the type specimen of *Euryaspis brachycephalus* there occur a number of partially calcified cartilaginous endoskeletal bodies. The first of these is a triangular plate which I take to be homologous with the quadrangular plate in *Coccosteus* called the

[1] L. Hussakof and W. L. Bryant, Catalog of the Fossil Fishes in the Museum of the Buffalo Society of Natural Science. *Bull. Buffalo Soc. Nat. Sci.*, Vol. XII, 1918, p. 91. Other plates of *Aspidichthys* are described by W. L. Bryant, Fossil Fishes of the Hamilton Shales of New York, *N. Y. State Mus. Bull. 281, p. 37*.

"sub-median-dorsal," which as its name implies, is located mesially beneath the posterior extension of the median dorsal shield. Below and behind this plate are a pair of long, slender, sigmoidal pieces, perhaps representing the pelvic girdle. These are followed by a segmented series of closely apposed bodies which resemble partially calcified vertebræ with short neural and hæmal spines.

I am aware that the notochord in the *Arthrodira* so far as known is never segmented or calcified, and there is no proof that the rather obscure bodies in question have anything to do with *Euryaspis*. Taken in connection with the associated calcified plates they are certainly suggestive of vertebræ. Perhaps their main interest relates to the hope that further collecting may bring to light other endoskeletal parts of these fishes.

Methods of Preparation

In preparing the fossils for study the usual, oft described methods were followed.

For uncovering partially embedded fossils I make use of tools which I believe are new to the purpose and which I find extremely efficient. These are automatic center punches. They may be obtained in various sizes and the spring tension may be adjusted to strike blows of varying force. The blows may be directed at any angle in the exact direction required, and are less liable to damage the specimen than are hammer and chisel. The steel is very hard and tough and the removable punch tips may be reground to form chisels. In photographing black fossils on dark red limestone I used panchromatic plates with suitable color screens.

CLASSIFICATION OF THE LOWER DEVONIAN FISHES OF BEAR TOOTH BUTTE, WYOMING

Class Ostracodermi
- Sub-class Pteraspidomorphi
  - Order Heterostraci
    - Family Pteraspidæ
      - Genus *Pteraspis* Kner and Huxley

Pteraspis bucheri n. sp.
Pteraspis dorfi n. sp.
Genus *Cardipeltis* Branson and Mehl.
Cardipeltis wallacii Branson and Mehl.
Genus *Cyrtaspis* n. gen.
Cyrtaspis ovatus n. sp.

CLASS PISCES
DIVISION A. Elasmobranchii
Sub-class Placodermi
Order Arthrodira
Family Acanthaspida
Genus *Euryaspis* n. gen.
Euryaspis brachycephalus n. sp.
Genus *Svalbardaspis* Heintz.
Svalbardaspis montanus n. sp.
Genus and sp. indet. cf. *Arctaspis* Heintz.
Family Coccostidae
Genus *Coccosteus*
Coccosteus chamberlini n. sp.
Sub-class Selachii (?). Ichthyodorulites.
Genus *Onchus* Agassiz.
Onchus penetrans n. sp.
Genus *Bulbocanthus* n. gen.
Bulbocanthus rugosus n. sp.
DIVISION B. Teleostomi
Sub-class Dipnoi
Family Dipteridæ
Genus *Dipterus* Sedgw. and Murch.
Dipterus sp.

DESCRIPTION OF THE FAUNA

OSTRACODERMI

FAMILY PTERASPIDÆ

Pteraspis bucheri n. sp.

Pl. I; Pl. II, Fig. 1; Pl. III, Fig. 1–3; Pl. V, Fig. 2; Text Fig. 1.

Type: The impression in yellow limestone of the dorsal and ventral shields of a fish, together with the dorsal spine and a few detached scales (No. 13480 Princeton University Geologi-

PLATE I

cal Museum, Paleontological Series), collected by Professor W. H. Bucher.

This is a large species measuring 127 mm. from the front of the rostral to the end of the dorsal shield. The specimen is weathered and otherwise damaged (Pl. I). The bone has been dissolved by the elements leaving only an impression of the outer surface in the matrix. It is possible however to recognize most of the various plates making up the dorsal carapace. These are demarcated not only by the arrangement of the superficial ornament, but by grooves where the plates are fused together. Lankester,[1] long ago, pointed out that the plates of the dorsal shields in the family *Pteraspidæ* unite by anchylosis rather than by suture. There are to be seen, then, in this fossil, lying in natural association, the upper surface of the rostral, a pineal, parts of the two orbitals, the dorsomedian and the major portions of the branchial and cornual plates of the left side. Behind the dorsal shield one may see the impression of the dorsal spine and beyond the head lies the front half of the ventral shield (Text Fig. 1).

The head is broken at about the level of the orbits so that I cannot be certain that the eyes were wholly inclosed within the orbital plates, but I believe that they were so inclosed and that they were located well down on the sides of the head. The rostral area is short and rounded in front, much as in *Pteraspis vogti* Kiaer, a small species from the Downtonian of Spitzbergen. In general the body outline of the present species is very similar to *P. vogti* except at the hinder part of the shield (compare Text Figs. 1 and 2). The outlines of the component plates however are quite different.

Behind the rostral plates are the paired orbitals. Only

[1] E. Ray Lankester, The Fishes of the Old Red Sandstone of Gt. Britain. Part I. The Cephalaspidæ. London, 1868, p. 18.

PLATE I

Pteraspis bucheri n. sp. Type (No. 13480 Prin. U. Geol. Mus., Pal. Ser.). Impression of outer surface of dorsal and ventral shields, with cornual and branchial plates of one side. A portion of a detached orbital (?) plate lies between snout and ventral shield. The dorso-median spine is seen behind the carapace. × 2/3.

the front portions of the plates are preserved, but they must have extended well down along the sides of the carapace. A detached fragmentary plate with curved outlines, lying in

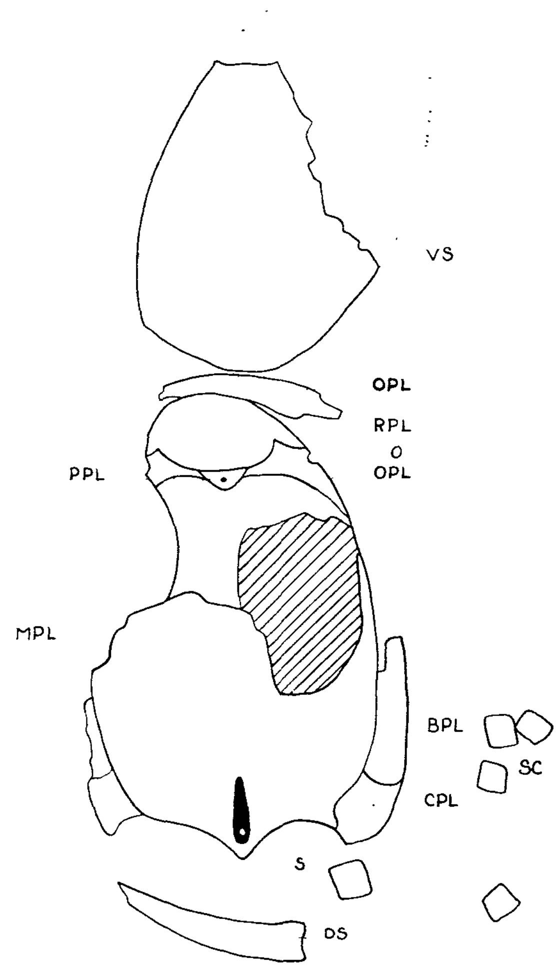


FIG. 1.—*Pteraspis bucheri* Bryant. Sketch of type specimen. BPL, branchial plate; CPL, cornual plate; DS. dorsal spine; MPL, median dorsal plate; O, orbit; OPL, orbital plate; PPL, pineal plate; RPL, rostral plate; S, opening in shield for dorsal spine; SC, detached scales; VS, ventral shield. The rear end of the ventral shield has broken away. Its complete outline is restored after another specimen. × 1/2.

front of the rostral, may be the missing rear portion of the left orbital plate.

Separating the orbitals and lying between the rostral and the median dorsal is a small pineal plate which is distinct,

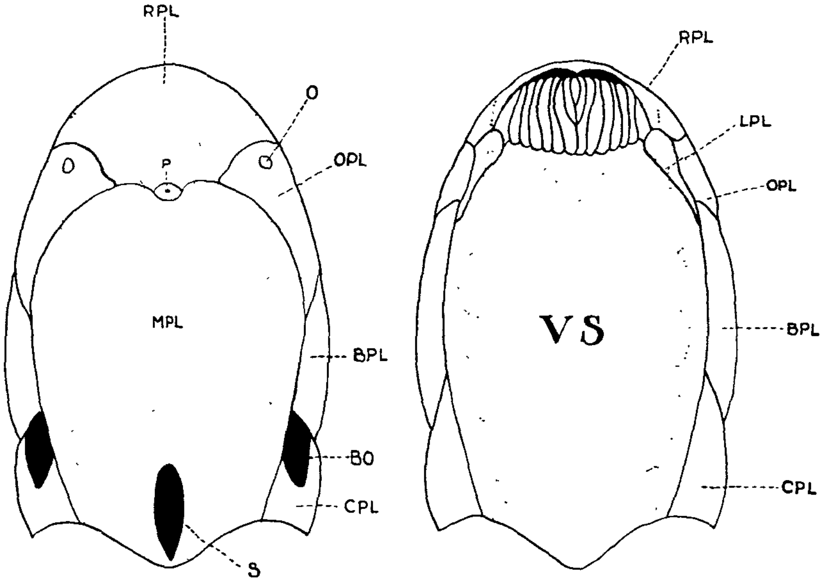


FIG. 2.—*Pteraspis vogti* Kiaer. Dorsal and ventral shields. (After Kiaer 1928.) Sensory canal system indicated by dotted lines. That of the dorsal side adapted from *P. primaevus*. BO, branchial opening; BPL, branchial plate; CPL, cornual plate; LPL, lateral plate; MPL, median dorsal plate; O, orbit; OPL, orbital plate; P, pineal covering; RPL, rostral plate; S. cavity for dorsal spine; VS, ventral shield.

not only in the type specimen but in another head of the same species in the collection (No. 13481, Pl. III, Fig. 2). In the centre of this plate is located the prominent pineal pit. So far as I know, this is the first *Pteraspis* in which a separate pineal plate has been recognized. It marks a further step in the progressive subdivision of the dorsal shield which occurred in the later history of the family *Pteraspidæ* as it emerged from the Silurian into the Devonian.

The median dorsal plate is broken and crushed flat in front, but retains much of its original convexity behind. At the rear end of the shield in the median line is the narrow

opening or slot into which fitted the dorsal spine. This opening was entirely within the border of the shield. An impression of the dorsal spine is seen directly behind the shield. It is imperfect at each end. The sides were sculptured with striæ running parallel to the longitudinal axis.

The greater part of the branchial and cornual plates of the left side are preserved in impression in their natural relations, but I can see no indications of a branchial opening between them. The cornual plate was not apparently prolonged into a spine.

The front half of the ventral shield is seen in impression lying in advance of the rostral. Another specimen (No. 13482, Pl. II, Fig. 1) enables us to complete its description. The ventral shield is tongue shaped, gradually widening for more than half its length whence it narrows to the rear. Both specimens are crushed flat but were, no doubt, originally somewhat convex. The shield was originally about 105 mm. in length by 70 mm. in greatest width. Its outer surface exhibits the superficial striæ running generally parallel to the anterior margin, but towards the sides of the plate the neighboring striæ are deflected so as to run parallel to those margins. This ornamentation, as is true of the other plates of the carapace, consists of fine parallel grooves and ridges, four or five in the space of a millimeter. The ridges are distinctly crimped in some areas giving the appearance of rows of minute tubercles. Elsewhere, the crimping is not so apparent.

A number of scales from that part of the body behind the carapace are to be seen as impressions in the matrix. Some of them are ridge scales (Pl. V, Fig. 2). They are small, diamond-shaped and have a narrow margin of overlap. The

---

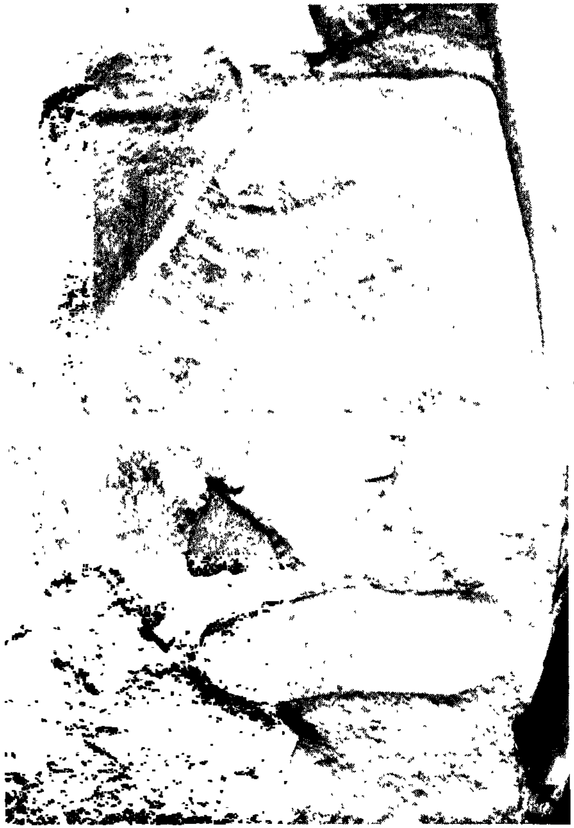
PLATE II

FIG. 1.—*Pteraspis bucheri* n. sp. (No. 13482 Prin U Geol. Mus., Pal. Ser.). Ventral shield crushed (visceral aspect). × 3/4. The bone is very thin and, in front, the outer surface shows through sufficiently so that the ornamentation can be seen.

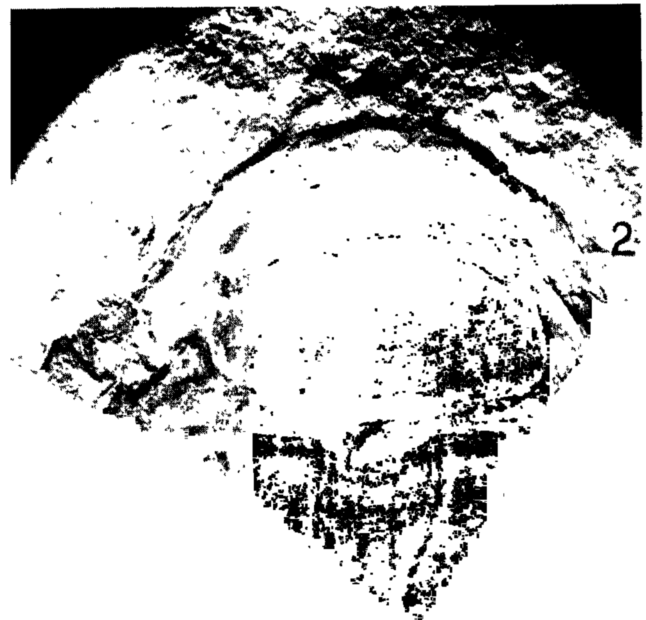
FIG. 2.—*Pteraspis dorfi* n. sp. (No. 13486 Prin. U. Geol. Mus., Pal. Ser.). Ventral shield uncrushed. × 3/4. The shield is preserved mostly as a mould of the visceral surface with patches of the bone adhering, these patches showing the ornamentation of the outer surface.

PLATE II

PLATE III



1



2

ridge scales are boldly arched. They are about 10 mm. in length by about as many in breadth. The ornamentation differs from that of the carapace, for the longitudinal costæ are intersected at right angles by a series of parallel horizontal grooves.

There is no indication of sensory canals anywhere on the type specimen. This was to have been expected from the fact that in the *Pteraspidæ* these canals are located in the middle layer of the bone tissue, which in this instance has entirely disappeared, but another specimen shows two plates (No. 13483, Pl. III, Fig. 1) of this species in natural association. These seem to consist of a portion of the ventral shield together with a club-shaped "lateral plate" which Kiaer [1] has already found in *Pteraspis vogti*. The ventral plate is broken in such a way that a sensory canal is exposed. The main canal has numerous very short tubuli which branch out on one side of the canal and open with conspicuous pores.

A head somewhat better preserved than the type, is shown on Pl. III, Fig. 2 (No. 13481 Prin. U. Geol. Mus., Pal. Ser.). It exhibits the rostral, pineal, parts of the orbitals and the front margin of the median dorsal. Besides the above mentioned specimen, there are in the collection four other ventral shields mostly preserved as moulds of the interior surface, and a detached branchial (?) plate (No. 13484, Pl. III, Fig. 3).

The large size, the presence of a pineal plate and the configuration of the other plates distinguish this species from any

[1] Johan Kiaer, "The Structure of the Mouth of the Oldest Known Vertebrates, Pteraspids and Cephalaspids." *Palæobiologica,* 1928, Vol. I, p. 122.

PLATE III

Pteraspis bucheri n. sp.

FIG. 1.—Part of ventral shield showing sensory canal. (No. 13483 Prin. U. Geol. Mus., Pal. Ser.) Apparently auchylosed to the shield is a large lateral (?) plate. × 1.

FIG. 2.—Head in visceral view showing rostral and pineal plates; with parts of the orbitals, and the front margin of the median-dorsal. (No. 13481 Prin. U. Geol. Mus., Pal. Ser.) × 1 1/3.

FIG. 3.—Detached branchial (?) plate. (No. 13484 Prin. U. Geol. Mus., Pal. Ser.) × 1.

of its European relatives. From *Glossoidaspis giganteus* Branson and Mehl, of the Jefferson formation of Utah, it is distinguished by the shape of its median dorsal shield, the coarser ornamentation and by the shape and ornament of the scales.

I take pleasure in naming this species in honor of its discoverer, Dr. W. H. Bucher of the University of Cincinnati.

Pteraspis dorfi n. sp.
Pl. II, Fig. 2; Pl. IV; Text fig. 3.

Type: A dorsal shield imbedded in red limestone (No. 13492 Prin. U. Geol. Mus., Pal. Ser.), collected by Professor Erling Dorf.

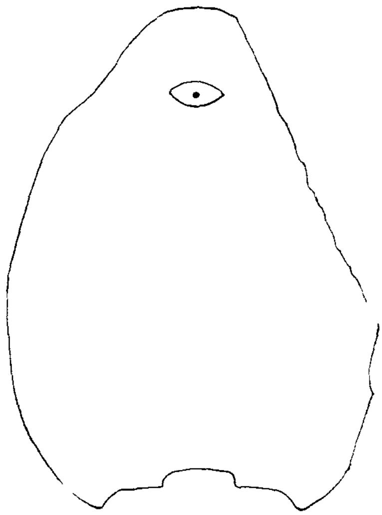


FIG. 3.—*Pteraspis dorfi* Bryant. Outline of dorsal shield of the type specimen, visceral aspect, showing pineal plate. × 1/2.

This species is represented by a very large *Pteraspis* seen in visceral aspect. The dorsal shield (Text Fig. 3) seems to be complete except in its left margin and its contour is shown with diagrammatic clarity (Pl. IV). The bone adheres to the

PLATE IV

Pteraspis dorfi n. sp. Type (No. 13492 Prin. U. Geol. Mus., Pal. Ser.). Inner view of dorsal shield showing pineal plate. × 9/10.

PLATE IV

matrix and is smooth and polished. Characteristic heart-shaped lines on the median dorsal show a comparatively rapid growth towards the snout. Its length is 135 mm. Its greatest width about 100 mm.

The lateral plates of the carapace, if present, are so completely fused as to obscure entirely their outlines. Even the crushing of the shield which is now pressed quite flat did not dislodge a single plate. A small pineal plate however is conspicuous between the rostral and the median dorsal.

The cornua are not produced into spines and there is no opening in the shield for the reception of the median dorsal spine. It is probable that there was a median dorsal spine directly behind the shield, and that the curious emargination at the end of the shield is related to it.

The bone is quite thin and there are no other impressions of internal organs than the pineal pit which is conspicuous. Stensio [1] has remarked that this condition in *Pteraspis* as compared with the Silurian *Palæaspis* and *Cyathaspis* indicates a progressive degeneration of the hard skeleton which was accompanied by a subdivision of plates. These American fossils also indicate progressive gigantism.

There are no indications of the orbits which of course means that we have here only the top of the cranium. Neither is there any evidence of branchial openings.

I am unable to locate the sensory canals with certainty although a pair of ridges on the rostral may represent the paired longitudinal canals seen in other species. When a certain amount of grinding on one side failed to develop them I desisted fearing to injure the unique type specimen.

The superficial sculpture of the upper surface of the shield as exposed at one or two points, consists of the usual fine parallel grooves and ridges. About eight of these ridges are contained within a millimeter.

A large ventral shield in the collection with identical

[1] Erik A: Son Stensio, "The Downtonian and Devonian Vertebrates of Spitsbergen. Family Cephalaspidæ." *Det norski videnskaps-akademi i Oslo. Skrifter om Svalbard og Nordishavet. Resultater av de Statsunderstottded Spitsbergenekspeditioner* No. 12, 1927, p. 317.

ornamentation no doubt belongs to this species. It is apparently uncrushed (No. 13486, Pl. II, Fig. 2). It is broadly convex in every direction, flatter in front, The sides descend gradually and for the rear half of the shield the convexity amounts to about 8 mm. in depth. The rear end is rather sharply constricted. The length of this shield is 115 mm. Its greatest width is 77 mm.

While this species closely resembles *Pteraspis bucheri* in outline of the carapace, it differs from it in the much finer superficial ornamentation, in the absence of an opening in the shield for the dorsal spine, and in the outline of the base of the dorsal shield. Its ornamentation is somewhat coarser than that of *Glossoidaspis giganteus* Branson and Mehl, and the median dorsal plate as shown by lines of growth is much wider in proportion to its length.

I have named this species in honor of Dr. Erling Dorf of Princeton University, who discovered the type specimen.

Cardipeltis wallacii Branson and Mehl
Pl. V, Fig. 1.

This species which was lately described by Drs. Branson and Mehl[1] from the lower member of the Jefferson near Logan, Utah, is represented in our collection by three fragmentary specimens. The best of these (No. 13487), collected by Professor W. H. Bucher, consists of the rear end of the dorsal shield showing its complete outline. The shield measures 145 mm. in greatest width and is similar in form, size and sculpture to the type. None of the other fragments in the collection are from the front part of the shield and I am unable to add anything to the excellent description given by the above named authors.

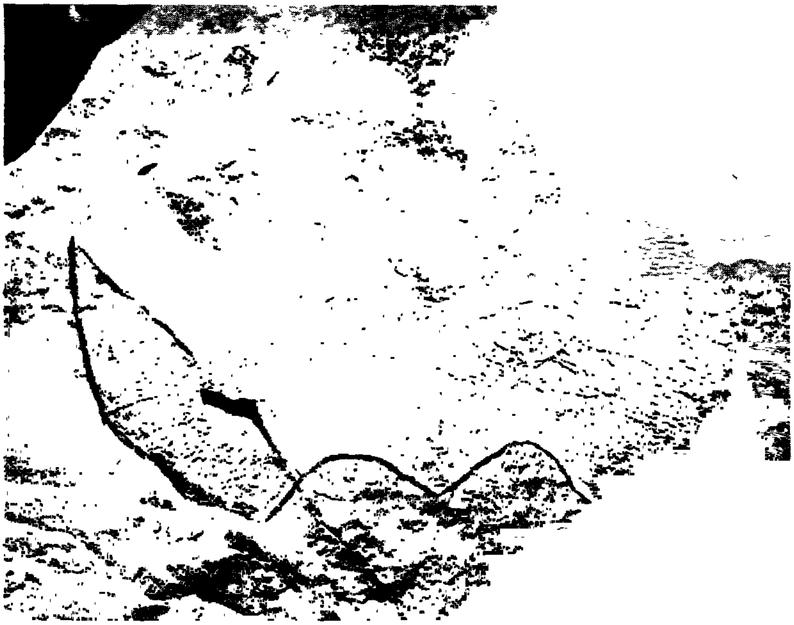
[1] Op. cit., p. 517.

PLATE V

Fig. 1.—*Cardipeltis wallacii* Branson and Mehl (No. 13487 Prin. U. Geol. Mus., Pal. Ser.). Rear end of dorsal shield, outer surface. × 3/5.

Fig. 2.—*Pteraspis bucheri* n. sp. Type (No. 13480 Prin. U. Geol. Mus., Pal. Ser.) Detached ridge scales showing ornamentation. × 4.

PLATE V



2

While the species no doubt belongs in the family *Pteraspidæ*, I am unable to agree with Drs. Branson and Mehl that it is very close to the Silurian *Palæaspis*. The large eyes, their position far back in the head and the fact that the basal part of the bony head shield was not sufficiently developed to come into contact with such internal structures as the semicircular canals, pineal organ or gill sacs, in my opinion set this genus well apart from such genera as *Palæaspis* and *Cyathaspis*. It is apparently closer to the form which I shall next describe.

Genus *Cyrtaspis* n. gen.

Pteraspids with broadly ovate dorsal shield and ventral shield about as wide as long. The rostrum is short and broad. The eyes, large and placed well forward, are indicated by notches in the dorsal shield. The bony carapace is thin. The visceral side of the dorsal shield bears no impressions of internal organs and hence must have overlaid a thick cartilaginous endocranium. Outer surface of carapace sculptured with fine grooves and beaded ridges. Number and arrangement of plates of dorsal shield unknown.

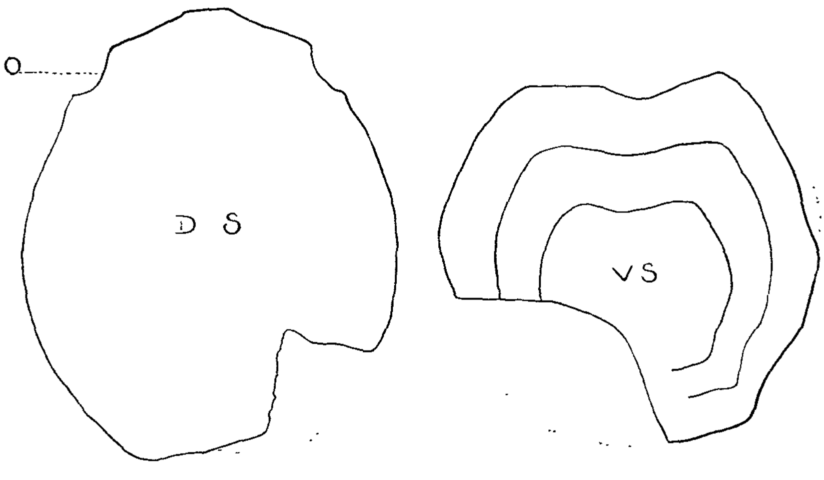


FIG. 4.—*Cyrtaspis ovatus* Bryant. Restored outline of dorsal shield (visceral aspect) and ventral shield (outer aspect) of type specimen. DS, dorsal shield; VS, ventral shield; O, orbit. Two inner lines on ventral shield record stages of growth. × 3/5.

Cyrtaspis ovatus n. sp.
Pl. VI, Fig. 1, Text fig. 4.

Type: Dorsal and ventral shields of the same individual preserved as natural moulds of the inner surface of the dorsal shield and of the outer surface of the ventral (No. 13488 Prin. U. Geol. Mus., Pal. Ser.), collected by Professor W. H. Bucher.

This species is known from a single specimen which had lain exposed to the elements until nearly all of the bone had weathered away. The ventral shield had slipped backwards and sideways but is still partially covered by the dorsal shield. A fracture in the matrix enables that portion of the dorsal shield which overlaps the ventral to be lifted up, exposing the complete forward contour of the latter.

The ovate contour of the dorsal shield is complete except for a fragment broken away from the right side at the posterior end. The shield measures 95 mm. in length along its median axis, and is 80 mm. in greatest width. The very large orbits are indicated by curved notches in the margin of the shield. A line connecting their anterior margins would be only about 8 mm. back from the tip of the rostral.

The shield is not badly crushed and much of its original arching still remains. It is broadly rounded from side to side, the arch being about 5 mm. in height opposite the orbits. It is also arched from front to rear in about the same degree, the snout being more sharply depressed. Except for the orbits, no impressions of internal organs can be seen, and there are no indications of cornual or other component plates.

The ventral shield has only its left posterior corner broken away so that its complete contour is easily made out. It

PLATE VI

FIG. 1.—*Cyrtaspis ovatus* n. gen. & sp., Type (No. 13488 Prin. U. Geol. Mus., Pal. Ser.). Dorsal shield (visceral aspect) and ventral shields (outer aspect). The left rear end of the dorsal shield has been removed to expose the ventral shield. × 7/8.

FIG. 2.—*Bulbocanthus rugosus* n. gen. & sp., Type. Spine. (No. 13502 Prin. U. Geol. Mus., Pal. Ser.) × 2.

PLATE VI

measures 75 mm. in length on the median axis and 80 mm. in greatest width. It is thus seen to be very broad in proportion to its length.

It is gently arched from side to side and from front to rear, both arches being about 5 mm. in height at the present time although originally they were probably higher. The highest point of the arching of the shield occurs at about its centre.

A clear impression of the superficial ornamentation is to be seen on the mould of the ventral shield as well as a number of grooves indicating progressive stages of growth. I have outlined two of these on my sketch (Text Fig. 4). The sculpture consists of a series of fine grooves alternated with beaded ridges. Five of these ridges occupy the space of a millimeter. They parallel quite closely the contour of the margins of the shield and there is very little forking or intercalation of lines.

While the dorsal shield of this fish resembles in contour that of *Cyathaspis* the two genera are clearly separated by the very large orbits of *Cyrtaspis* and the absence of the characteristic impressions of internal structures. The shape of the ventral shield is also quite different being much broader in proportion to its length.

It is quite clear that the mouth of this fish must have been nearly terminal.

PISCES.

ORDER ARTHRODIRA

FAMILY ACANTHASPIDA

Genus *Euryaspis* n. gen.

This genus belongs in the *Acanthaspid* division of the *Arthrodira*. The head is short and broad with wide snout. The large eyes are directed laterally. The lateral margins of the skull are sub-parallel with no extended postero-lateral corners such as occur in *Coccosteus* and *Dinichthys*.

The plates of the head shield are firmly anchylosed, their boundaries obliterated. The sensory canal system is similar

to that in other *Acanthaspids*. The median dorsal shield is broad and arched, the median crest rising to a conspicuous node near the centre of the shield. Ventral armor of the *Acanthaspid* type. Lateral spines present. Dermal plates ornamented with tubercles of various size in the same region. Dentition unknown.

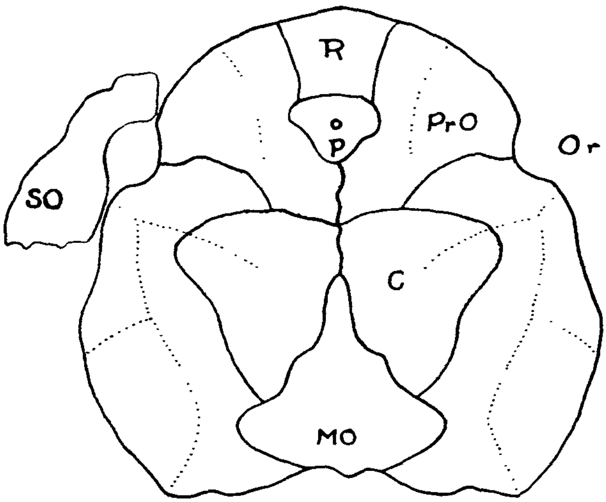


FIG. 5.—*Euryaspis brachycephalus* Bryant. Sketch of cranial roof with the outlines of some of the component bones. C, central; MO, median occipital; Or, orbit; P, pineal; PrO, pre-orbital; R. rostral; SO, sub-orbital. Outlines of the other bones are uncertain. Dotted lines represent sensory canals. × 2.

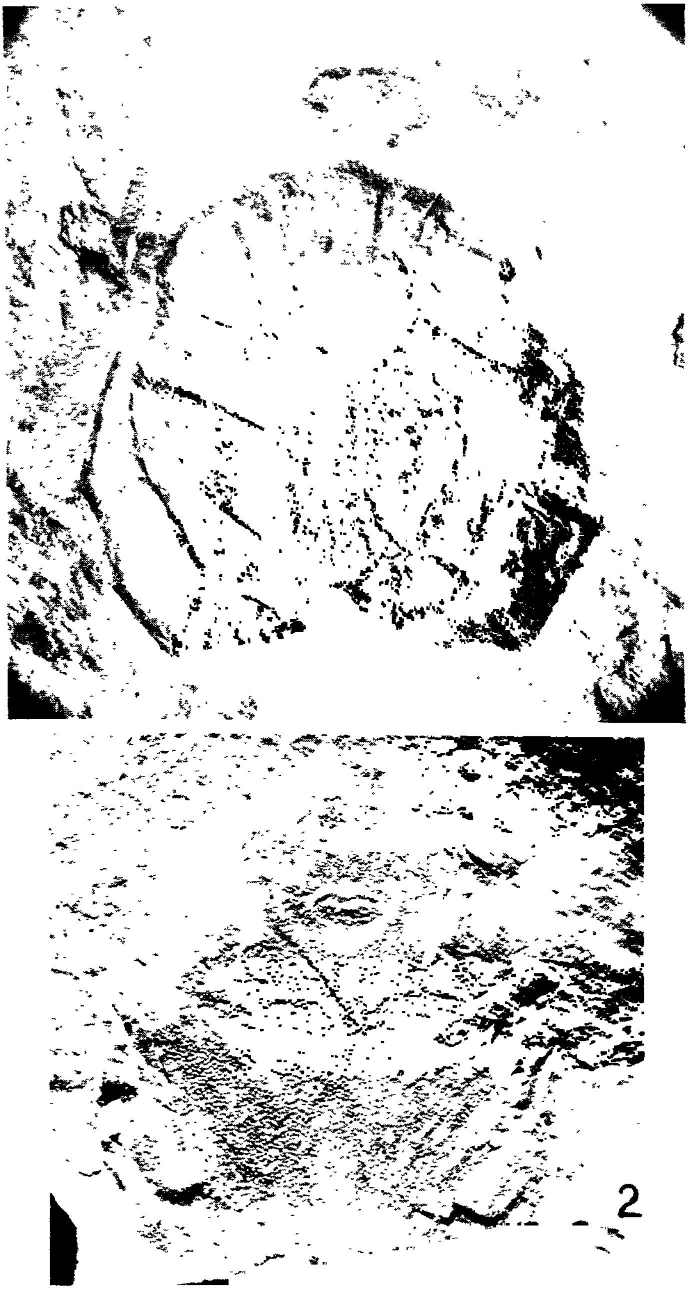
Euryaspis brachycephalus n. sp.

Pl. VII, Figs. 1, 2; Pl. VIII, Figs. 1–4; Pl. IX, Fig. 3; Text Figs. 5–6.

Type: A complete head-roof in red limestone (No. 13493 Prin. U. Geol. Mus. Pal., Ser. Pl. VII, Fig. 1), collected by Professor Erling Dorf. Besides the type, the collection contains four other heads more or less damaged, five detached median dorsal shields, four antero-ventro-lateral plates, and a number of other plates of dubious position.

While the cranial shields are all small, averaging about 30 mm. in length, the fusion of the component plates insures

PLATE VII



that we are dealing with adult fishes. The head is arched from side to side especially in the occipital region. The snout is depressed. The bones are so completely fused that suture lines are seen from the inside only in certain instances, while on the outside they are obliterated and overgrown with tubercles. Nevertheless in some specimens it is possible by reason of a slight thickening of their margins to observe the boundaries of certain bones (Text Fig. 5).

Viewed from the visceral side one may recognize the triangular median occipital bone, broad behind and narrow in front. It extends well up between the centrals, dividing them for more than half their length. As seen from the inner side the median occipital forms only a small part of the head margin. In one specimen (No. 13494, Pl. VII, Fig. 2) the centrals can be seen quite distinctly. They are shaped like butterfly wings.

The pineal bone is certainly distinct from the rostral. It is wider than long as in *Phlyctænaspis*. On the type specimen two lines may mark the lateral boundaries of the rostral which in that case is rather narrow. A suture line terminating outwardly at about the middle of the orbital notch marks the forward boundary of the post-orbital. This suture bends downward to meet the central, but I am not certain whether it meets it at the point indicated in my sketch or closer to the median line.

The sutures separating the external-occipital from the marginal, and the latter from the post-orbital are obliterated. I find no certain indications of nasal notches in the anterior boundary of the cranial roof as preserved.

PLATE VII

Euryaspis brachycephalus n. gen. & sp.

FIG. 1.—Complete cranial roof seen mostly in visceral aspect, but exposing the sensory canal system of one side and certain sutures. A sub-orbital bone lies in front of the head (No. 13493 Prin. U. Geol. Mus., Pal. Ser.). Type. × 2.

FIG. 2.—Cranial root of another specimen seen in outer aspect. The outlines of the median occipital, pineal, and centrals can be faintly seen on this specimen. (No. 13494 Prin. U. Geol. Mus., Pal. Ser.) × 2.

I am able to trace the sensory canal system of the head. This is formed by open grooves and is as represented in Text Fig. 5. It is less complex than in typical *Arthrodira*, but closely resembles that of other *Acanthaspids*, for instance *Jaekelaspis decipiens* W. Thus the supra-orbital canal is much shorter than in *Coccosteids*, while a number of canals found in the latter genus are absent.

A detached left sub-orbital bone is seen lying in front of the head in the type specimen. It is ornamented with tubercles but no sensory canals are preserved, most of the actual bone having broken away.

The outer surface of the various bones in this species is closely studded with smooth tubercles, pointed or pear-shaped (Pl. IX, Fig. 3). These vary greatly in size in the same area as noted in some other *Acanthaspids*. Often the tubercles bend and almost overlap one another, giving a scale-like effect. Elsewhere they may be quite erect. They are not arranged concentrically around centres of ossification except on the dorso-median and other trunk plates and on the scales.

Several dorso-median shields with the typical ornamentation of this species were found in the collection. One of them (No. 13495), its left side broken away, lies between two heads on the same small block of limestone (Pl. VIII, Fig. 1, and Text Fig. 6). It actually may have belonged with one or the other of these crania. It is 28 mm. in length and was originally about 32 mm. in width, almost as wide as the heads.

PLATE VIII

Euryaspis brachycephalus n. gen. & sp.

FIG. 1.—Dorsal shield, outer aspect. The left side has been broken away. (No. 13495 Prin. U. Geol. Mus., Pal. Ser.) × 2.

FIG. 2.—Right antero-ventro-lateral plate preserved as an impression in the matrix. The spine is broken and the missing distal end apparently lies above. The fine tuberculation of the plate is too minute to be seen. (No. 13490 Prin. U. Geol. Mus., Pal. Ser.) × 1 2/5.

FIG. 3.—Detached scale from the caudal region. (No. 13497 Prin. U. Geol. Mus., Pal. Ser.) × 4.

FIG. 4.—Impression in the matrix of a right postero-ventro-lateral (?) plate. (No. 13496 Prin. U. Geol. Mus., Pal. Ser.) × 2.

PLATE VIII

The anterior border is only slightly excavated. Uncrushed specimens show that the shield was greatly arched from side to side as well as from front to rear, rising from all sides to a

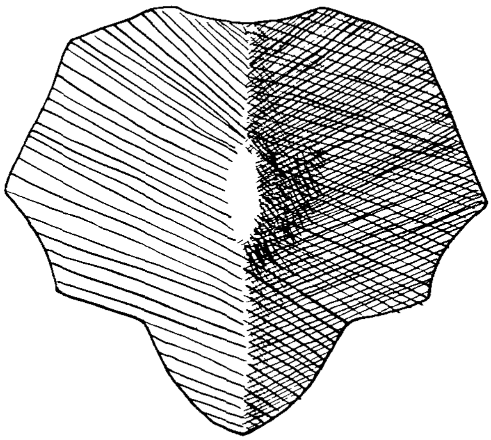


FIG. 6.—*Euryaspis brachycephalus* Bryant. Dorsal shield. × 2.

prominent node on the longitudinal axis of the shield somewhat forward of the middle. This node certainly must be homologous with the "pronounced protuberance or hollow spine" which Branson and Mehl found on the dorsal shield of *Camptaspis utahensis* in the Jefferson formation of Utah.[1]

There seems to have been no longitudinal ridge on the underside of the median dorsal shield. On one or two well preserved specimens there is a longitudinal groove or infolding of the external surface which extends from the centre of the shield to the anterior margin. This infolding should produce a ridge on the visceral side, but there is no specimen before me which exhibits that side of the shield except in section posterior to the middle.

While this shield seems to have been proportionately much wider than in other Arthrodires, there is nothing in its external appearance to indicate that it is composed of more than one element. It seems to have occupied the whole dorsal area of the trunk armor, and the dorso-lateral elements must have

[1] Op. cit., p. 511.

been correspondingly reduced. Some other shields in the collection are a little smaller.

The ventral armor is known only by detached plates, one of these being the spinous antero-ventro-lateral. There are four of these in the collection. Most of them are preserved only as fairly well defined impressions of plates which have broken or weathered away from the matrix. The largest of these is 33 mm. in length by 23 mm. in width including base of spine (No. 13490, Pl. VIII, Fig. 2). The anterior margin shows the recessed area overlapped by the intero-lateral plate.

I am unable to determine in what manner the spine was attached to the antero-ventro-lateral. In all cases as preserved the spines are short, their distal extremities having apparently broken away. A detached spine lying above the antero-ventro-lateral in the illustration may represent the distal portion of this or another spine.

The antero-ventro-lateral plate is long in comparison to its width, thus resembling that in *Phlyctænaspis*. The contour of the inner margin suggests that the pair of plates met for some distance along the median axis of the fish so that the antero- and postero-ventro-median plates must have been well separated.

The external surface of the plate is ornamented with very fine tubercles. Towards the outer margin of the spine they suddenly become much enlarged and along that margin take on the appearance of blunt denticles.

Certain other detached plates with similar ornamentation occur in the collection. One of these (No. 13496, Pl. VIII, Fig. 4) seems to be the right postero-ventro-lateral, preserved as an impression in the matrix. It shows area of overlap on its upper and inner margin. It is much to be hoped that material showing the plates of the body cuirass in natural association will soon be forthcoming.

Evidence that the caudal region of this fish was covered with scales is offered by a number of detached scales with the typical sculpture of the species. One of them (No. 13497)

having the character of a ridge scale is figured on Pl. VIII, Fig. 3.

In another part of this paper I have referred to certain endoskeletal structures of calcified cartilage which may belong to this fish.

Svalbardaspis montanus n. sp.

Pl. X, Fig. 1.

Type: A large rostral plate in yellow limestone (No. 13485 Prin. U. Geol. Mus., Pal. Ser.), collected by Professor W. H. Bucher.

This genus as defined by Anatol Heintz [1] includes a number of lower Devonian *Acanthaspids* from the Woods Bay region of Spitzbergen. Some of these forms doubtless will be withdrawn from the genus when better understood. Two species, *S. typicus* Heintz and *S. Stensioi* Heintz, are characterized by short and very broad rostral plates extending nearly from one eye notch to the other. The pineal pit is included within the borders of the plate. While the rest of the head plates in these species are firmly anchylosed, the rostral plate is less solidly fused and nearly always becomes detached from the skull.

In our collection there is a large detached rostral plate which so closely resembles those of the above mentioned species, that I provisionally place it in the genus *Svalbardaspis*. Part of the plate is preserved as the original bone in visceral aspect, the remainder as an impression of the outer surface.

The plate is 27 mm. long by 59 mm. wide, the sides being well drawn out in front and somewhat depressed as is the entire front margin. The remainder of the plate is flat or even slightly concave.

The most curious feature of this plate is the position of the pineal pit. This is located far forward and must have been considerably in advance of the eyes. The pit itself seems to be contained in a very small diamond-shaped pineal plate located like an island in the midst of the rostral.

The ornamentation of this plate consists of minute tuber-

[1] Op. cit., p. 56.

cles which gradually increase in size towards the anterior margin.

Gen. and Sp. Indet. Cf. *Arctaspis*

A larger and doubtless undescribed species of an *Acanthaspid* fish is evidenced by a fragment of the head roof on a slab of red limestone in the collection (No. 13508, collected by Professor E. L. Perry. This fragment which is an impression in the matrix with part of the bone adhering, shows the margin of the right side of the head including most of the post-orbital and marginal bones and a part of the external occipital. The sensory canals of the region are well preserved. So far as one may judge by the fragment it is closer to *Arctaspis* than to any other genus.

It is figured in Pl. IX, Fig. 4.

Family Coccostidæ.

Coccosteus chamberlini n. sp.

Type: An antero-ventro-median plate in red limestone (No. 13498 Prin. U. Geol. Mus., Pal. Ser.), collected by Professor R. T. Chamberlin. Supplementing the type on another slab are an antero-dorso-lateral plate apparently of the same species and examples of the dentition (Pl. IX, Fig. 1).

The antero-ventro-median is preserved as a beautiful impression in the matrix. It is twice as long as wide, about the same proportions as in *Coccosteus decipiens* Ag., but is more cruciform in shape (Pl. IX, Fig. 2). It shows clearly the areas overlapped by the intero-laterals and antero-ventro-laterals.

PLATE IX

Fig. 1.—*Coccosteus chamberlini* n. sp. Impression of right antero-dorso-lateral plate (No. 13491 Prin. U. Geol. Mus, Pal. Ser.). × 1 1/5.

Fig. 2.—*Coccosteus chamberlini* n. sp. Type. Impression of antero-ventro-median plate (No. 13498 Prin. U. Geol. Mus., Pal. Ser). × 1.

Fig. 3.—*Euryaspis brachycephalus* Bryant. Ornamentation of dorsal shield enlarged. (No. 13489 Prin. U. Geol. Mus., Pal Ser.) × 6.

Fig. 4.—Gen. and spec. indet. cf. *Arctaspis*. Fragment of the cranial roof of an Acanthaspid fish showing, mostly as an impression of the outer surface, the right margin of the cranium with sensory canals. (No. 13508 Prin. U. Geol. Mus., Pal. Ser.) × 1 1/2.

PLATE IX

By these areas of overlap the distal ends of the intero-laterals are seen to have been rather broad. They did not meet in the median line, but were separated by a narrow extension of the antero-ventro-median. The margins of the antero-ventro-laterals were quite straight so far as they came in contact with the antero-ventro-median, not rounded as in *C. decipiens.* The posterior end of the antero-ventro-median plate clearly came into contact with the postero-ventro-median. The ornamentation consists of fine stellate tubercles.

A right antero-dorso-lateral plate in the collection may belong to this species as it is comparable in size and ornamentation (No. 13491, Pl. IX, Fig. 1). It is interesting because from its areas of overlap one may deduce something of the shape and position of the surrounding plates. This also is preserved as an impression in the matrix and is complete except for the condyle.

A wide process of the plate extends above the area overlapped by the median-dorsal plate. Hence a wider gap than usual separated the median-dorsal from the median-occipital of the head. This overlapped area also shows that the antero-lateral corners were rounded as in most species of *Coccosteus*, not sharply angular as in *Dinichthys*.

The area overlapped by the antero-lateral is very broad and must have given considerable rigidity to the armor in the region when the head was articulated to the trunk. The antero-lateral was not so pointed above and its upper margin was not bounded by the antero-dorso-lateral to so great an extent as is usual in *Coccosteids.* The front margin of the antero-dorso-lateral bends sharply forward in this region to follow the contour of the head.

A curious feature of this plate is found in its posterior margin. This is not perpendicular to the axis of the fish as usual in *Coccosteids* but slopes downward and forward at a considerable angle. The postero-dorsal extension of the plate must have been grasped on both sides by the postero-dorso-lateral.

A sonsory canal originating in the region of the condyle

crosses the plate from front to rear. It is not bifurcated and no doubt represents the beginning of the lateral line.

This plate has certain features that are unusual in *Coccosteus* and may later, when more material is at hand, prove to belong in a different genus.

The gnathal elements apparently belonging to this fish consist of the greater part of the functional end of a right infero-gnathal (mandible) showing the entire cutting margin and beak; and a complete right postero-supro-gnathal. Both are preserved as impressions with a little bone adhering, the former of the inner surface, the latter of the outer (Pl. X, Figs. 2–3). Neither of these elements, which may have belonged to the same individual, show any trace of denticles. But curiously enough the outer surface of the postero-supro-gnathal is seen to be closely studded with minute tubercles exactly like those of the outer surface of the body plates.

This species is named in honor of Professor R. T. Chamberlin of the University of Chicago, who, as a member of the expedition, discovered the type specimen.

SUB-CLASS ELASMOBRANCHII. ICHTHYODORULITES

Onchus penetrans n. sp.

Pl. X, Fig. 4.

Type: A complete spine in red limestone (No. 13504 Prin. U. Geol. Mus., Pal. Ser.), collected by Professor Erling Dorf.

Spine bilaterally symmetrical, long, slender, tapering to an acute point. It is gently arched and laterally compressed. The inserted portion is short and narrow. Central cavity

---

PLATE X

FIG. 1.—*Svalbardaspis montanus* n. sp., Type. Rostral plate showing enclosed pineal (No. 13485 Prin. U. Geol. Mus., Pal. Ser.). × 1.

FIG. 2.—*Coccosteus chamberlini* n. sp. Impression of right postero-supro-gnathal. (No. 13499 Prin. U. Geol. Mus., Pal. Ser.) × 2.

FIG. 3.—*Coccosteus chamberlini* n. sp. Impression of inner surface of the functional portion of infero-gnathal. (No 13500 Prin. U. Geol. Mus., Pal. Ser.) × 2.

FIG. 4.—*Onchus penetrans* n. sp., Type. Spine. (No. 13504 Prin. U. Geol. Mus., Pal. Ser.) × 2.

PLATE X

apparently open only at the base. Sides sculptured with ten to twelve ridges some of which are intercalated in the basal region and do not extend to the apex. Margins smooth.

The spine is 37 mm. in length and only 2 mm. in width. The inserted portion is 5 mm. in length.

Genus *Bulbocanthus* n. gen.

Spines small, with bulbous inserted portion. Exserted portion thin, sinuous in lateral view and tapering. Sides ornamented with numerous carinæ. Posterior edge set with denticles directed upwards.

Bulbocanthus rugosus n. sp.

Pl. VI, Fig. 2.

Type: A spine in red limestone (No. 13502 Prin. U. Geol. Mus., Pal. Ser.), collected by Professor Erling Dorf.

Spine with a flattened bulb-like root. Exserted portion flattened, thin, slightly sinuous, long and tapering. Sides ornamented with meandering, crenulated ridges. Posterior margin with a series of flattened denticles directed somewhat upwards.

Length of spine 37 mm. Greatest width of exserted portion 4 mm.

Two complete and several broken spines are found on the same slab with the type, together with numerous fish remains representing various families and sub-classes.

The spines somewhat resemble the Carboniferous *Listracanthus* spines except for the curious tuberous root. This was unornamented and hence was apparently inserted in the body of the fish. In *Listracanthus* too, the denticles appear on both margins. Bulbous roots occur in the segmented spines known as *Phlyctænacanthus* and also in *Gampsacanthus* but they otherwise differ widely.

The internal cavity of the spine extends nearly to the apex but I cannot determine if it opened on either margin.

While I have provisionally placed this spine with the *Elasmobranchii*, I am frankly uncertain of its origin and sus-

pect that it may later prove to belong to some member of the *Heterostraci.*

Dipterus sp. (?)

A badly weathered and otherwise damaged head in the collection (No. 13503), collected by Professor W. H. Bucher, indicates the presence of a dipnoan fish in the Bear Tooth Butte beds. The tesselated arrangement and punctate surface of the few uninjured roof bones point to a species of *Dipterus* of normal size. The head is too badly weathered for further definition.

TUBULODON TAYLORI, A WIND RIVER EOCENE TUBULIDENTATE FROM WYOMING

By G. L. JEPSEN

(Read April 22, 1932)

Lower Eocene fossil collecting continued during the summer of 1931 in the Wind River Basin of Wyoming under the auspices of the Princeton Scott Fund. Most of the tiny jaws and teeth which were discovered by members of the party represent species long previously founded and described,[1] but one small fragmentary specimen, collected by William Zachary Taylor, Princeton '32, from a rich horizon of the upper Wind River type section [2] northwest of Arminto, near the geographic center of Wyoming, is an unexpected and puzzling new mammalian genus. The name *Tubulodon taylori* is here proposed for the specimen, the genus indicating the curious tooth structure, and the species dedicated to the discoverer.

Tubulodon appears to be related to the living aard vark [3] (*Orycteropus*) and to the Pliocene fossil members of the genus from Persia and Samos. Other reputed tubulidentate fossil remains are either too meagre to be of comparison value or they definitely are not related to *Orycteropus* although their true affinities remain enigmatic.

This paper describes *Tubulodon* and discusses the reasons

[1] Granger, W., "A Revision of the American Eocene Horses," *Bull. A. M. N. H.*, Vol. XXIV, Art. XV, 1908. Sinclair, W. J., "A Revision of the Bunodont Artiodactyla of the Middle and Lower Eocene of North America," *Bull. A. M. N. H.*, Vol. XXXIII, Art. XXI, 1914. Matthew, W. D., and Granger, W., "A Revision of the Lower Eocene Wasatch and Wind River Faunas," *Bull. A. M. N. H.*, Vol. XXXIV, Arts. I, IX, X, XIV, and XVI, 1915; Vol. XXXVIII, Art. XVI, 1918. Granger, W., and Gregory, W. K., "A Revision of the Eocene Primates of the Genus Notharctus," *Bull. A. M. N. H.*, Vol XXXVII, Art. XXXIV, 1917.

[2] *Lambdotherium* is the critical genus of this "Lost Cabin" horizon. Other genera are *Eotitanops*, *Eohippus*, *Notharctus*, *Vulpavus*, *Paramys*, *Coryphodon*, *Bathyopsis* and many more.

[3] "Earth Pig" of the Dutch Boers.

for assigning the genus to the Tubulidentata. The drawings are by the author, with assistance on Figs. 1 and 2, Plate I, by Mrs. Sheldon Howe.

Orycteropus has recently attained the distinction of being the only genus to be the sole occupant of an order of living mammals, the Tubulidentata. Various writers have divided *Orycteropus* into several species, some of which are probably only slightly distinguishable, but geographically separated, races. The Pliocene species, *Orycteropus gaudryi*, differs from the living aard vark chiefly in size, being about four-fifths as large as the smallest living species.

For these reasons, some interest may attach to an account of the order in which the characters of *Tubulodon* suggested relationship with *Orycteropus*. Parts of both lower jaws, a skull fragment, a broken phalanx, coprolites, and a few bone fractions compose the associated remains. Each slender jaw retains two peg-like molars and the empty socket of the last, or third molar. The left jaw also preserves the last premolar, but on the right jaw this tooth lacks its crown, fortunately so, because the breakage led indirectly to the present conclusion that the specimen is what remains of an ancient aard vark.

The molars demanded first attention because of their cylindrical shape above the sockets, and because they appeared to be implanted in the long slender jaws by simple single roots. Only one other small Lower Eocene genus, *Palæanodon*, has peg-like molar crowns and single-rooted molars. The back part of the horizontal ramus of *Palæanodon*, however, is edentulous whereas in *Tubulodon* the

PLATE I

FIG. 1.—Labial side of left jaw of *Tubulodon taylori*, showing crowns of M_{1-2} and roots of last premolar exposed by dissection of the bone. $\times$ 4.6.

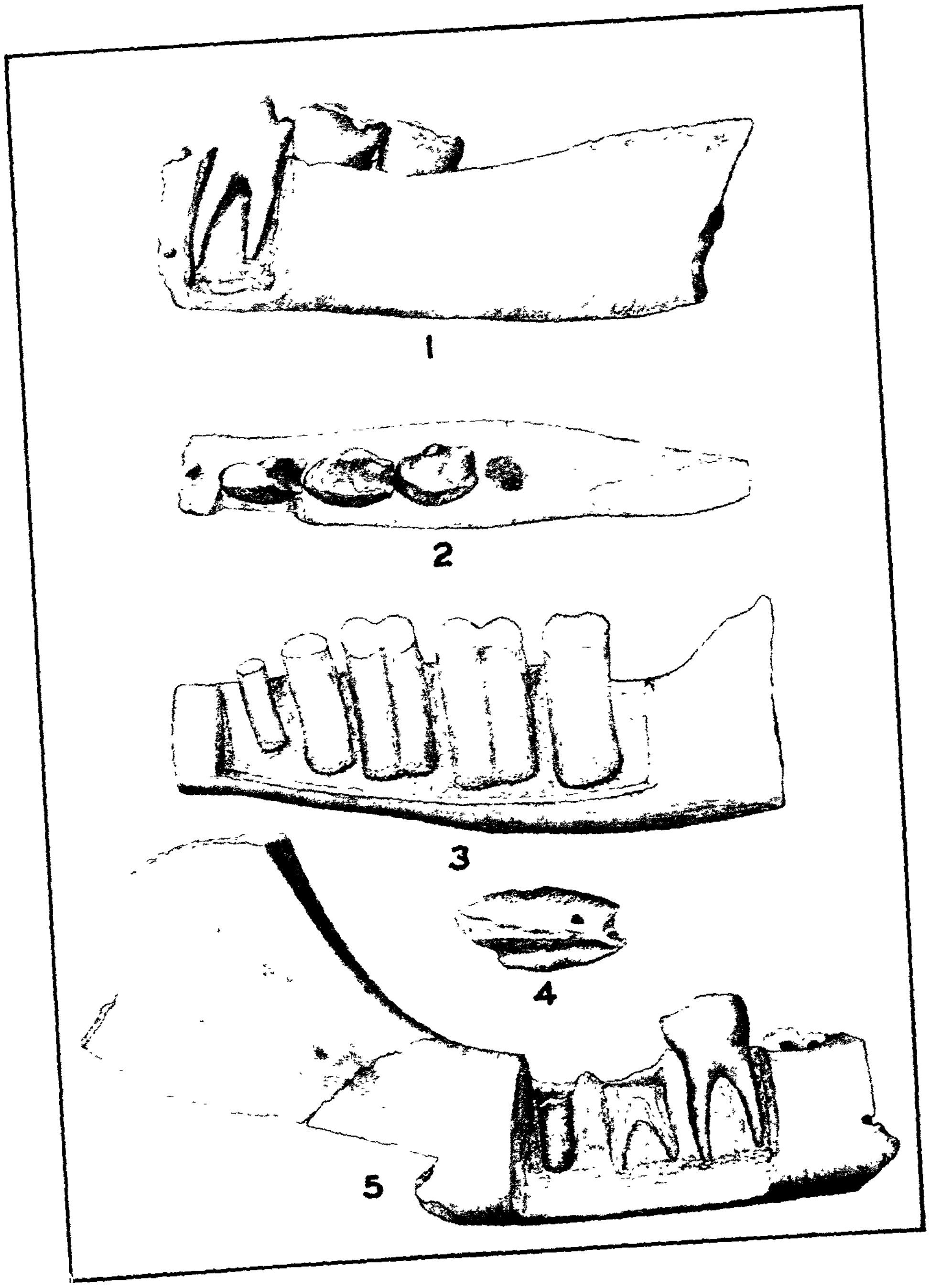
FIG. 2.—Superior aspect of same jaw. $\times$ 4.6.

FIG. 3.—Labial side of left jaw of *Orycteropus capensis*. $\times$ 1.

FIG. 4.—Inferior labial aspect of symphysial fragment of right jaw of *Tubulodon*. $\times$ 4.3.

FIG. 5.—Labial side of right jaw of *Tubulodon taylori*, showing broken last premolar, complete M_1, root of M_2 sectioned and polished, and matrix-filled alveolus of M_3. $\times$ 4.6.

PLATE 1



broad ascending ramus begins exterior to the last molar, as it does in some of the Armadillos and other living edentates.

One of the first observations of interest when the molars were examined was the lack of enamel upon the crown tops and its thinness on the sides of the teeth. Nor is the absence of capping enamel a result of wear, for in the rare event that ordinary Eocene teeth have all top enamel worn off, the cusps also are completely eroded away, and the crown is reduced to a low basin in the dentine with an elevated rim of tough peripheral enamel. In an intermediate state of wear where the cusps are still present but greatly reduced, islands and peninsulas of enamel also remain. Here, on *Tubulodon*, to the contrary, although the cusps are structurally low, they are well formed and the crown remains high (hypsodont), indicating that enamel never covered the top. Even in the deep basin of the last premolar, where the surface was protected by the elevated surrounding cusps, no enamel appears.

Some Eocene teeth have thinner enamel on the tops of the crown than on the sides, but on every specimen examined, other than *Tubulodon*, the enamel was harder and more resistent, during life, than the dentine, as the differential wear testifies. On *Tubulodon* teeth, almost the reverse condition is true, for the side enamel has been reduced, by an infinity of minute abrasions and removed chips, to a level slightly lower than the dentine. On the polished sections of the teeth the enamel is a little harder than the dentine, but not so pronouncedly so as on other Eocene teeth. The original relative hardness-difference in all was probably modified by fossilization.

This novel condition of soft enamel may have been responsible for the fact that several of the cusps of *Tubulodon* teeth were completely broken off, apparently during life, because the fracture-surfaces are battered and pitted. Both first molars (left and right) have only one cusp apiece which shows no signs of fracture before the animal's death. These breaks could have been produced only by pressure or percus-

sion on the crown top and not on the sides, for in each case a long flake of dentine and enamel has been removed down the side of the tooth below the missing cusp.

Of the right last premolar only the sheared stump remains, and it is broken so that there is a high edge with a little enamel on the tongueward side, while the other side descends below the top of the alveolus, Pl. 1, Fig. 5. The edge above the socket is worn and pitted, again strongly suggesting that the owner had dental difficulties during life, explainable, as will be shown, by his food habits. The bone of the alveolus-brim itself appears to have splintered and healed. Certainly the tooth breakage occurred before burial because the pulp cavity was filled with the gray fine sand matrix, whereas the cavities of the unbroken teeth contain crystallized calcium carbonate.

Neither extreme youth nor age marks the specimen. The bone structure is that of an adult, lacking the characteristic porous and fibrous appearance of immaturity. Yet the teeth indicate, as described above, that the animal had not approached senility. It appears to have reached early adultism. This detail is recorded here to facilitate future comparison of *Tubulodon* with what may be exhumed of tubulidentate ancestors less removed from *Orycteropus* than is *Tubulodon*, because it is a group whose teeth and jaws undergo profound changes of proportion with age. Frequently, when considering fragmentary fossil types, the necessity of allowing for age variation is neglected and individuals of different stages of development are compared.

Next, in making further comparisons with the living toothed edentates, the premolar structure was examined. The broken stump of the right last premolar exposed a divided pulp cavity, one branch extending into each of the two apparent roots. Following this observation, the bone was chipped and ground away from the outside of the whole left last premolar. As surmised, two roots appeared, Pl. 1, Fig. 1, and the microdissection was continued on the outside of the right jaw below the crowns of the molars, Pl. 1, Fig. 5.

The root of M_1 divides into two down in the socket halfway from crown top to root tips, and the root of M_2 likewise branches, still farther from the crown. Although M_3 is missing from both jaws, the shape of the vacant alveoli indicates that these teeth each had but one root, of a tapering cylindrical shape, permitting them to escape easily from the sockets. The double-rooted condition of the teeth, other than M_3, verified the former impression that this new fossil has no close relationship to *Palæanodon* or to any other known edentates.

Attention next turned to the dendritic tubules which can be seen in the dentine on top of the teeth and through the thin amber-colored enamel on the sides of the crown, but not in the enamel itself. To see them better the right M_2 was sectioned vertically and transversally and the cut surfaces were polished.

FIG. 1.—Diagrammatic section of right M_2 of *Tubulodon taylori*, × 10, showing tubules in the dentine and the high narrow main pulp cavity. Enamel on crown sides represented by solid black. Anterior side on the right.

The original belief that the tubules might be merely the result of an unusual method of fossilization was quickly adjusted when their orderly arrangement parallel to the root surfaces was determined.

A number of other similarly petrified Eocene teeth and jaw fragments were likewise prepared for comparison. None of them show analogous tubules although some have, in the dentine, a few slender threadlike markings which twist and loop in all directions. They are also discontinuous, highly variable in size, and extend into the enamel.

In the sectioned molar of *Tubulodon* (Fig. 1) the main pulp cavity differs from the normal proportions in Eocene teeth. It is narrow and high ("taurodont") in the columnar part above the root juncture, occupying scarcely more than the middle third of the diameter of the tooth. In the roots it is also narrow, and

opens broadly at the root tips, lacking the usual constriction.

As in many Wind River teeth, the main pulp cavity is now filled with intergrown calcite crystals and the tubules are also filled in a few places, rendering them locally invisible. They are mostly open, however, or contain opaque material. Although they vary in size, the majority measure from .02 mm. to .03 mm. in diameter.

A few enter the dentine from the central pulp cavity but by far the greater number arise along the periphery of the roots. As they ascend, roughly parallel to the outside of the tooth, they branch and twist until toward the tooth top they become a contorted mosslike maze. But even here they conform to an obvious system of ascent into the low cusps and parallelism to the flat crown surfaces.

By the presence and character of these tubules, *Tubulodon* is even more certainly eliminated from relationship with the edentates and, in fact, with all other orders of early Tertiary mammals. Here the problem of classification stood until *Tubulodon* teeth were compared with those of the Pliocene and the living species of *Orycteropus*.

Orycteropus premolars vary in number, size and shape but they are all single columns, oval in cross section, Pl. 1, Fig. 3. The first two lower molars are bicolumnar, like two conjoined cylinders, and the much smaller third molar varies from a single column, with no vertical grooves on the sides, to a condition like M_2, pronouncedly bilobed. There is no enamel on the teeth and they grow persistently from the open roots.

More than one hundred years ago Cuvier remarked upon the extraordinary character of *Orycteropus* teeth, pointing out that their structure is unlike that of any other mammalian teeth.[1] Since then other writers have extended the observations, and nearly all investigators have compared the adult teeth to sections of a cane or reed, for instead of containing a central pulp cavity, the dentine is traversed from bottom

[1] Cuvier, G., *Recherches sur les Ossemens Fossiles*, Tome V, part 1, Paris, 1823, pp 134–135.

to top by numerous small pulp canals or tubules. The dentine around the canals is demarcated into long irregular prisms, making, in cross section, polygons of varying numbers of sides, like the wax of an imperfect honeycomb.

The literature about *Orycteropus* teeth neglects the fact that many of the tubules arise on the outside of the teeth. This is apparent even upon the teeth of young individuals and is a very distinct character of adult teeth. As the animal grows the teeth increase in diameter, but not, as has been stated by Owen, by the addition of new pillars of dentine, each perforated by a new tubule. Instead, the number decreases with age, because, as the grinding surfaces are worn down apace with the growth of the teeth, some of the tubules, entering from the outside, are completely removed. The tubules were counted at the bases of the left and right third molars of an adult *Orycteropus* and found to number 715 and 730, respectively. The third molar of a young aardvark, American Museum of Natural History, No. 51371, with unworn crown, has between 650 and 700 tubules at the base although the surface area is only a little more than half that of either of the adult tooth bases where the tubule number is but slightly greater.

Minute calcigerous tubes enter the dentine of *Tubulodon* teeth from the main pulp cavity and also from the tubules at right angles to the latter. In *Orycteropus* teeth, the calcigerous tubes radiate from the medullary or pulp canal of each "denticle" and are limited in length by the boundaries of that prism. The calcigerous tubes of *Tubulodon* are not so definitely terminated, and they interdigitate in the spaces between the tubules, although the differentiation into "denticles" appears to be incipient, indicated in part by the fracture-habit of the dentine.

Several theories have been conjured to account for the origin of the unique structure of *Orycteropus* teeth. Owen originally believed them to be an aggregate of teeth [1] and Weber suggested that they were the result of a complex

[1] Owen, Richard, *Odontography*, Vol. I, p. 318, 1845.

infolding or invagination from the outside, with a subsequent loss of enamel. A closer approach to what *Tubulodon* indicates about the derivation of the dentine prisms and medullary canals of *Orycteropus* was made by Einar Lönnberg in 1905,[1] when he sketched a development of the highly specialized teeth of *Orycteropus* from simple teeth with main central pulp cavities. His postulates almost fit the structure of the teeth of *Tubulodon*. He believed, however, that the tubules all developed from the central pulp cavity, basing his conclusion upon one of the supernumerary premolars of a young *Orycteropus afer*, wherein, according to his description and illustrations, no tubules enter from the periphery. Molars of a young aardvark, A. M. N. H. No. 51371, referred to above, show that many of the tubules do curve toward the periphery of the tooth and end blindly, but that others enter the dentine from the outside.

Lönnberg believed, further, that *Orycteropus* teeth are homologous with the roots of the teeth of ancestors of the genus, and of other mammalian teeth. In 1890, double-rooted milk premolars of *Orycteropus* which never erupt the gums were described by Oldfield Thomas,[2] and since then his observations have been corroborated and extended by Broom.[3]

A fragment of the symphysial region of the right jaw of *Tubulodon* is preserved, Pl. 1, Fig. 4. If this bit has been properly determined, *Tubulodon* probably had no anterior teeth because the broken superior edge shows no pits or other signs of tooth roots. If incisors, canines, or front premolars were present they had extremely short roots, or else the jaws were extraordinarily deep at the symphysis. But this is out of harmony with the preserved structure both of this fragment and of the low posterior part of the jaw.

The distal end and part of the shaft of one phalanx was

[1] *Arkiv för Zoologi*, "On a New *Orycteropus* from Northern Congo and Some Remarks on the Dentition of the Tubulidentata," Band 3, No. 2, 1906–1907, pp. 1–35.

[2] Thomas, Oldfield, "A Milk Dentition in *Orycteropus*," *Proc. Royal Soc. of London*, Vol. XLVII, p. 246, 1890.

[3] Broom, R., "On the Milk Dentition of *Orycteropus*," *An. So. Af. Mus.*, Vol. V, p. 381, 1906–1909.

found associated and is therefore presumably a part of *Tubulodon*, but the preserved part is not very diagnostic because it resembles the toe bones of several genera, including *Orycteropus*. At any rate it is quite unlike homologous bones of any edentates. It will be described in detail below.

At present the exact position of the small skull fragment upon the brain case is undeterminable because it differs so markedly from what are believed to be similar portions of all other skulls, living and fossil, with which it was compared. The bone is very thick.

The associated fossil dung pieces are ovoid in shape and preserve the sphincter marks. Most of the substance has been replaced by a brittle calcium carbonate which retains indefinite markings, probably as reflections of former structures. High-power microscopic examination of broken and polished surfaces reveals the presence of numerous irregular cavities, some of which are partially filled with calcite, but others contain only small desiccated masses of brown and yellow substances. The breakage sometimes follows uneven wavy separation-planes, possibly occupied at one time by thin, filmy materials.

After the calcium carbonate is dissolved in hydrochloric acid, there remains a heavy brown organic flocculate, some mica flakes, and small grains of quartz and feldspar. Most of the inorganic particles have maximum diameters of less than .1 mm. but some, especially the quartz fragments, are nearly half a millimeter across.

The brown organic material gives the characteristic violet color-reaction for chitin when washed and treated with fresh iodine in potassium iodide solution and then with a drop of concentrated solution of zinc chloride.[1] When burned, the substance smells like scorched hair or finger nail or insect test, all of which have been incinerated for comparison.

Such a persistence of chitin seems remarkable but it is a notoriously durable substance when entombed in impervious

[1] *The Microtomists' Vade Mecum.* Arthur Bolles Lee. Phila., 1913. P. Blakiston's Sons and Co.

matrix. The finely divided nature of the chitin in this case makes tests difficult and prevents an estimate of the degree of alteration or replacement.

The chitin points to an insectivorous habit although no pieces are big enough to identify as portions of insect skeletons. Quartz and feldspar grains were obviously accidental inclusions with the animals' food and probably account for the eroded and fractured state of the teeth.

A technical diagnostic description of *Tubulodon* is inserted here in order to draw upon it for the conclusions which follow and to facilitate comparisons with future discoveries.

Detailed Description

Tubulodon taylori, new genus and species

Holotype.—Princeton No. 13418, right ramus with roots of last premolar, M_{1-2}, alveolus of M_3, and fragment of symphysial region; left ramus with last premolar, M_{1-2}, and alveolus of M_3; skull fragment; distal end of phalanx; coprolites. All associated.

Horizon and Locality.—Lost Cabin (*Lambdotherium*) zone of Wind River "formation," Lower Eocene, 5 miles northwest of Arminto, eastern edge of Wind River Basin, Natrona County, Wyoming. Found by W. Z. Taylor, August 9, 1931.

Diagnostic Characters.—Dentine of teeth traversed by small irregular tubules mainly arising from the outside of the roots but originating in part in the high, narrow ("taurodont") pulp cavity. Three molars; number of premolars unknown. Hypsodont columnar crowns; thin enamel on sides, none on top; cusps low and marginal. Last premolar with high central cusp, smaller anterolingual cusp, and two posterior cusps, one on each corner. Molars 1 and 2 have five main cusps, three on trigonid and one on each corner of talonid, but trigonid and talonid only weakly demarcated. Last premolar and first two molars double-rooted. Jaw long, stout (transversally wide), decreasing in depth posteriorly from the last premolar to the third molar, and increasing in width in the same distance.

The right symphysial fragment, Pl. I, Fig. 4, belonged close to the anterior tip of the jaw, at an undetermined distance anterior to the preserved remainder of the jaw.

Only part of the rugose symphysial scar remains but it is larger in proportion to the rest of the jaw than is the whole scar upon an *Orycteropus* jaw.

A large anterior mental foramen enters the anterior labial surface and continues as a tube through the fragment to the broken posterior edge. Another, smaller foramen pierces the bone a short distance posteriorly and higher. Anterior dental foramina are extremely variable in size and placement upon the jaws of the living *Orycteropus*.

Upon the inferior surface of this fragment there is a deep groove, curving medially at its anterior portion and ending in a pit. A corresponding groove is present on some recent *Orycteropus* jaws in a similar position, but it seems highly variable in both situation and development.

Other features of the lower jaw, in addition to the marked shallowness and sturdiness described above, are the broadly expanded ascending ramus and the deep, wide masseteric fossa with its heavy anterior rim. The thick bone of the ascending ramus is pierced by the dental foramen far back of the teeth and there is a posteriorly-deepening groove on the lingual side of the jaw below the molars. The tip of the ascending ramus, the condyle, and the inferior and posterior borders of the fossa are missing, but the preserved part is comparatively much larger and heavier than a corresponding portion of the jaw of *Orycteropus*.

Although the conventional cusp nomenclature is used here as a matter of convenience in describing the topography of the teeth, the terms are not intended to suggest homologies or derivations from other tooth types. The usual trigonid and talonid divisions are not clearly defined in this form.

The next-to-last premolar had two roots, to judge from the posterior margin of the alveolus, which is similar to a corresponding part of the socket of the last premolar.

This latter tooth has two roots which diverge slightly and then bend toward each other at their tips. The posterior root is shorter, stouter, and less curved than the anterior one. Above the alveolus, the quadricuspidate crown leans pos-

teriorly and lingually. This attitude places one of the four cusps, the protoconid (anterolabial cusp), almost in the center of the tooth when viewed from above. (See Plate I, Fig. 2.) A low ridge modifies the anterior slope of the protoconid, and another little ridge descends posteriorly to connect with the low cusp on the posterolabial corner of the crown, the hypoconid. Although only the broken, worn base of the anterolingual cusp (metaconid) remains, it was apparently a much smaller cusp than the protoconid, nearly opposite the latter. At the posterolingual corner appears the entoconid, opposite and subequal to the hypoconid. A central basin, cornered by the four cusps, deepens rapidly backward to descend at the rear of the tooth as a groove between the posterior cusps.

The right and left first molars show considerable variation in cusp development and, as indicated above, many of the cusps are broken and worn. On all of the molars the cusps are mere local enlargements of a low rim encircling an interior basin, interrupted between the hypoconid and the entoconid on M_1 and M_2 and also between the paraconid and the metaconid on the latter tooth.

M_1 has an oval-shaped crown with a low anterior cusp, the paraconid, which connects by a small ridge with the mid-labial cusp, the protoconid. Opposite the latter cusp is the metaconid, higher and more massive than the other elevations of the crown. On the left M_1 there is a smaller intermediate cusp between the metaconid and the paraconid, which may be merely a doubling of the metaconid or of the paraconid. The metaconid is broken off the right M_1, preventing comparison with the left. Hypoconid and entoconid rise at the posterior labial and lingual corners, respectively. Upon the postero-labial slope of the latter a tiny cusp appears, the hypoconulid, more distinct upon the left M_1 than upon the right. The paraconid is worn to a flat crescentic platform with a wing extending to the metaconid and one to the protoconid, from which it continues backward to the hypoconid.

Between the protoconid and the metaconid a low ridge

divides the interior basin into two unequal parts, a small anterior closed depression and a larger posterior hollow which slopes toward the rear of the tooth and becomes a groove between the hypoconid and the entoconid.

It has been indicated above that the point of juncture of the roots is halfway from crown top to root tips. As on the last premolar, the posterior root is stouter than the anterior one and the crown leans slightly postero-lingually.

M_2 is of the same width as M_1, but its lesser antero-posterior diameter makes it rounder and more cylindrical. It leans tongueward a little more and backward slightly less than does M_1. Here there are five main cusps, protoconid, paraconid, metaconid, hypoconid, and entoconid, arranged much as upon M_1 (Pl. I, Fig. 2). Upon the posterolabial base of the entoconid of the right M_2 there appears a small but distinct blunt-pointed hypoconulid. The corresponding left tooth bears no trace of this cusp. Similar to M_1, the postero-labial ridge from the paraconid joins the protoconid, but unlike M_1, there is no ridge or cusp between the paraconid and the metaconid, and the latter is not bilobed, but a single cusp. It is broken off the left M_2. The roots separate at a point 62 per cent of the distance from crown top to root tips, 12 per cent lower than the branching point of the roots of M_1 (Pl. I, Fig. 5).

Although M_3 is missing from both the left and the right jaws, the alveolus is single, unbranched, rounder, and slightly smaller than the upper part of the alveolus of M_2, but much larger than any single root of the other teeth.

Of the phalanx only the distal end and part of the shaft are preserved. The shaft is long and curves downward anteriorly. High, sharp keels bound the anterior articular groove which extends from the antero-superior surface down, around the end of the bone, and backward to a transverse depression on the plantar surface. It thus composes more than half an oval-shaped pulley whose long axis makes an angle of about 45° with the longitudinal axis of the bone. These characters eliminate close similarity of this phalanx to

the toe bones of most animals and are nearer to the structure of the proximal phalanx of the third right digit of *Orycteropus* than to that of any other toe bone with which comparison has been made, but this observation is of doubtful value.

MEASUREMENTS [1]

	Right mm.	Left mm.
Alveolar distances		
P_{last}–M_3	9.8	9 7
M_1–M_3	7.0	7.1
Diameters		
Anterior-posterior		
P_{last}		2.1
M_1	2.6	2.6
M_2	2.5	2.5
Transverse		
P_{last}		1.6
M_1	1.9	1.9
M_2		1.9

	Left mm.	Right mm.
Depth of jaw (lingual side)		
below P_{last}	4.9	4 9
" M_1	4.7	4.6
" M_2	4.5	4.4
" M_3	4.3	4.3
Width of jaw		
below P_{last}	2.7	2.7
" M_1	3.1	
" M_2	3.3	
" M_3	3.4	

Superficially, the comparison of the Pliocene form of *Orycteropus* and this early Eocene *Tubulodon* partakes chiefly of contrast, but the fundamental ordinal tooth structure was already incipient in the Wind River type, and many of the detailed changes of proportion from *Tubulodon* to *Orycteropus* are forecast in the former and can be interpreted as directed toward the latter. Certainly, with *Orycteropus* in mind as a specialized end product, *Tubulodon* is an almost ideal midstep from a generalized mammalian type. Between this latter form and the already highly specialized *Tubulodon*, however, there is a vast gap, greater than the void between *Tubulodon* and *Orycteropus gaudryi*.

Both of these time intervals need bridging by further fossil evidence before there can be any certainty about the relationships and derivation of either *Orycteropus* or *Tubulodon*. But the suggested kinship of these two greatly separated genera is based upon three considerations. First, *Tubulodon* is not related to any edentates, living or fossil

[1] Certain dimensions are omitted from the left and the right sides because the elements concerned were dissected or sectioned before being measured. In each case, however, they are preserved on one side.

(although the superficial resemblances are abundant), or to any contemporary Eocene mammals. Second, *Tubulodon* was compared with *Orycteropus* and seen to resemble it only after all other proposed relationships had been abandoned. Third, every major structural feature of *Tubulodon* was visualized twenty-six years ago by Lönnberg from his study of young specimens of *Orycteropus*.

In discussing the evolution of the teeth of *Orycteropus*, he described hypothetical stages which are now seen to consist of elements that developed at different times, because he was naturally unable to predict the relative acceleration of development of the various characters. For instance, he postulated that the molar crowns had lost the enamel before the tubules became, in the main, parallel to the outside of the teeth, whereas in *Tubulodon*, although the latter condition is fulfilled, the crowns still have enamel on the sides.

He did, however, forecast the following characters of *Tubulodon* as changes from a generalized mammalian type:

1. Loss of anterior teeth.
2. Nutritive canals or tubules in the dentine.
3. Columnar shape of teeth.
4. Two-rooted molars with almost normal pulp cavities.
5. Gradual loss of enamel.

Other evidences supporting the inclusion of *Tubulodon* in the order Tubulidentata are listed here:

1. Cusp pattern of the molars unlike that of other mammals, and apparently an approach toward complete reduction of the crown.
2. Symphysial region of jaw similar to that of *Orycteropus*.
3. Insectivorous habit, indicated by chitin and sand grains in the coprolites, and by broken teeth.
4. Small size—an extrapolation of the size difference between the living and the Pliocene *Orycteropus*.

From the evidence of the structures of *Tubulodon* it appears that the specialization of the teeth toward the columnar type found in *Orycteropus* began with the posterior teeth and progressed anteriorly. On *Tubulodon* the last lower

molar already had a single root which may or may not have been weakly bilobed, and the second molar roots were conjoined farther toward their tips than were those of the first molar. The Pliocene *Orycteropus gaudryi* consistently has a bilobed M_3 and the tooth in the recent *Orycteropus* varies considerably in shape, as described above. How the third lower molar in the tubulidentates could be nearly cylindrical in the Eocene, strongly bicolumnar in the Pliocene, and highly variable between these two shapes in the Recent, is difficult to explain. However, both the Pliocene and the Recent orycteropids present vast individual variation, and, as observed before, the molar cusp pattern varies from left to right on a single *Tubulodon* individual. Thus, any detailed work to interpret minute structures should be done with suites of specimens and not lone representatives. This may never be possible with the fossil specimens, but it serves as a warning to be cautious in drawing far-reaching conclusions from inadequate material.

The presence of tubulidentates in North America in the Eocene, and their later appearance in a remote area, Africa, is paralleled by many other known cases of distribution. Indeed, it was the opinion of Andrews[1] and Forsyth Major[2] that *Orycteropus* is of northern origin, having spread to Africa along with the rest of the Pliocene mammals, and was not derived from a southern land area. This is supported by the Pliocene distribution in Samos and Persia, which may indicate a migration route from North America to Africa through Asia. Andrews states further that the Pliocene form is more similar to the present species in N. Africa, *Orycteropus æthiopicus*, than it is to the southern, *Orycteropus capensis*.

In conclusion, it might be well to review some of the numerous opinions that have been expressed about the ancestry of *Orycteropus* and see how these theories agree with the evidence provided by *Tubulodon*, assuming the latter to be close to the ancestral line, or a segment of it.

[1] Andrews, W. C., "On a Skull of *Orycteropus gaudryi* Forsyth Major from Samos," *Proc. Zool. Soc.*, 1896, pp. 296–299.

[2] Major, Forsyth C. J., "On the Tooth of an Ant Bear," *Proc. Zool. Soc.*, 1893, pp. 239–240.

The variety of the earlier mental conceptions of a pre-*Orycteropus* is simply explained. Each investigator selected, in his own field of research, some one or two anatomical peculiarities of *Orycteropus* upon which to base his conjecture and, almost automatically, waved all other structures to the category of "too generalized to be evaluated." Indeed, nearly every conceivable ancient branch of the mammalian tree has been tapped and tested to see if *Orycteropus* could be grafted thereon. Later, the treachery of this practice led the men who studied isolated organs of *Orycteropus* to suspend their judgment entirely or to deal in generalities well fortified by justifiable vagueness. Recently the analyses are of a more comprehensive nature and, instead of single structures, groups of characters are selected as relationship criteria. But even yet, although *Orycteropus's* progenitors have been cautiously assigned to the Edentata, the Condylarthra (and other ungulate groups), the Marsupialia, the Ganodonta, and unknown Mesozoic forms, the genus remains, in plain truth, a complete puzzle.

In 1882 Flower[1] evaluated the anatomical structures of the edentates, including both the pangolins and the aardvarks in the order; but he stated that "the two old world forms Manidæ and Orycteropodidæ are so essentially distinct from all American families that it may even be considered doubtful whether they are derived from the same primary branch of mammals or whether they may not be offsets from some other branch, the remaining members of which have been lost to knowledge." He also says that the reproductive organs of *Orycteropus* "are formed upon a principle unknown in other Edentates, or, in combination, in other mammals."

Three years later, Parker was led "to suspect that the Cape anteater is . . . the only Edentate that can be looked upon as probably arising originally from a Metatherian or Marsupial stock, like the Insectivora."[2]

[1] Flower, W. F., "On the Mutual Affinities of the Animals Composing the Order Edentata," *Proc. Zool. Soc. Lond.*, 1882, pp. 358–367.

[2] Parker, W. K., "On the Structure and Development of the Skull in the Mammalia. Part II, Edentata," *Proc. Royal Soc. Lond.*, Vol. XXXVII, pp. 78–82.

The discovery of milk teeth in *Orycteropus* and other data caused Thomas to conclude in 1890 that the genus should be removed from the edentates. He added, "But if *Orycteropus* is not genetically a near relation of the Edentata, we are wholly in the dark as to what other mammals it is allied to."[1] He also declares that "one could not dare to suggest" that the ancestors of *Orycteropus* were to be sought in the direction of the perissodactyl ungulates.

In 1896 G. Elliot Smith[2] remarked, "If the brain of *Orycteropus* were given to an anatomist acquainted with all the other variations of the mammalian type of brain, there is probably only one feature which would lead him to hesitate in describing it as an exceedingly simple ungulate brain." This was quoted by Windle and Parsons[3] in 1899, and amplified by "Changing the word muscles for that of brain, this is practically our own view. There are only one or two points which would cause us to hesitate in describing *Orycteropus* as a generalized type of mammal, but those one or two are certainly in an Edentate direction."

Lönnberg, as reviewed above, studied the tooth structure of the tubulidentates in 1906 and saw no objections to deriving the group from the Condylarthra or some related types of early mammals.

A year later, during his study of the milk dentition, Broom briefly reviewed the previous conclusions and offered: "The evidence of six premolars would seem to remove it (*Orycteropus*) from any close relationship with other living forms, and to suggest the possibility of its being related to the Mesozoic mammals, a number of which have probably an identical formula."[4]

In his studies in 1909 on the organ of Jacobson, he points

[1] Thomas, Oldfield, "A Milk Dentition in *Orycteropus*," *Proc. Royal Soc. Lond.*, Vol. XLVII, 1819, pp. 246–248.

[2] Smith, G. Elliot, "The Brain in the Edentata," *Trans. of the Linn. Soc.*, 1896–1900. Second series, Zoology, Vol. VII, pp. 273–394.

[3] Windle, B. C. A., and Parsons, F. G., "The Myology of the Edentata," *Proc. Zool. Soc.*, 1899, pp. 990–1017.

[4] Broom, R., "On the Milk Dentition of *Orycteropus*," *An. So. Af. Mus.*, Vol. V, 1906–9, part 7, 1907, pp. 381–384.

out that *Orycteropus* differs so greatly in this structure even from the primitive ungulates such as *Procavia* or *Sus* that any supposed affinities must be extremely remote. More specifically, "The evidence from the study of this region would seem to point to *Orycteropus* being descended from a line of ancestors the earlier members of which were probably allied to the Marsupials, whilst the later members branched off from the Eutherian stem before any of the higher Eutherian types had been specialized." [1]

Beddard published his conclusions this same year: "The condition of the postcaval in *Orycteropus* appears to be an intermediate step in the reduction of the two veins found in the Monotremes and Edentates to the single right-hand postvenal postcaval of other Eutheria." [2]

Gregory also summarized the opinions of others in 1910 and added his own: "The prevailing resemblances of *Orycteropus* as regards the brain, dentition, and astragalus seem to be with the Protoungulates rather than with the Insectivores and Creodonts; although distant relationship both with the Ganodonta and Xenarthra is also possible."

The masterful and complete "Monograph of *Orycteropus afer*" by Sonntag and others in 1926 [3] completely considers all the known anatomy of *Orycteropus* and states, in conclusion: (1) The anatomical characters of *Orycteropus* are such that it should be placed in an order by itself. (2) The Tubulidentata are not related to the Pholidota and Xenarthra. (3) The Tubulidentata arose in the Cretaceous from the base of the stem Condylarthra, using that term as synonymous with Protoungulata. (4) Having arisen from the Condylarthra, the Tubulidentata evolved along ungulate lines in general and along the line of the Hyracoidea and Proboscidea in

[1] Broom, R., "On the Organ of Jacobson in *Orycteropus*," *Proc. Zoöl. Soc.*, 1909, Pt. II, pp. 680–683.

[2] Beddard, F. E., "On Some Points in the Structure of the Lesser Anteater (*Tamandua tetradactyla*), with Notes on the Cerebral Arteries of *Myrmecophaga*," *Proc. Zool. Soc.*, 1909, Pt. II, pp. 683–703.

[3] Sonntag, C. F., Woollard, H. H., and Clark, W. E. LeGros, "A Monograph of *Orycteropus afer*," *Proc. Zoöl. Soc.*, 1925, Pt. I, pp. 331–437; Pt. II, pp. 1185–1235; 1926, Pt. III, pp. 445–485.

particular. (5) The order Tubulidentata should be placed close to the Hyracoidea among the orders included under the great heading Ungulata.

Simpson, 1931, follows Sonntag in calling *Orycteropus* a derivative of a proto-ungulate stock.[1]

Thus, the consensus of opinion, based upon the study of the living *Orycteropus*, is that the tubulidentates were modified from the early proto-ungulates. The Pliocene fossil *Orycteropus* is too similar to the modern species to help trace the origin of the order.

The preserved fragments of *Tubulodon* do not support the proto-ungulate hypothesis. There is not a single character of the highly specialized jaws or teeth which can be considered as derived from or related to any described Paleocene form such as *Euprotogonia* or *Tetroclænodon* or *Phenacodus* or any other known early Tertiary group. By late Lower Eocene time the jaw and tooth structures of the tubulidentates had already specialized so far along their unique evolutionary trend as to mask any obvious relationship to other Tertiary mammals. This fact adds a further degree of plausibility to the opinions of Broom and Sonntag that the connection of the tubulidentates with other orders must be sought in the Mesozoic.

[1] Simpson, G. G., "A New Classification of Mammals," *Bull. Am. Mus. Nat. Hist.*, Vol. LIX, Art. V, pp. 259–283, 1931.

PRINCETON UNIVERSITY, PRINCETON, NEW JERSEY.

THE WILLIAM BERRYMAN SCOTT RESEARCH FUND.

ENGINEERING ASPECTS OF NOISE STUDIES

By S. K. WOLF

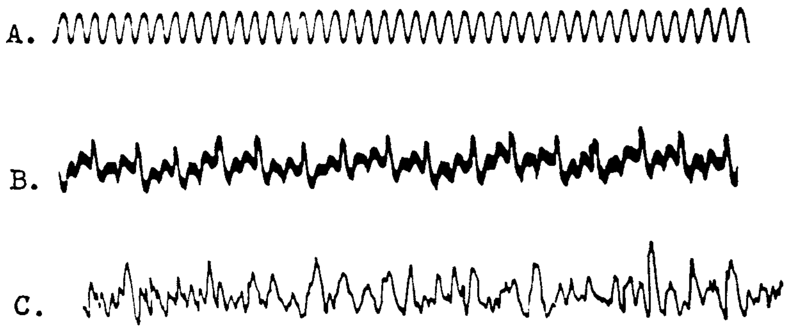
(*Read April 23, 1932*)

BECAUSE of the intimate relation between noise and movement, in addition to major sociological and economic changes, the machine age is characterized by an amount of noise new in human experience. This is especially evident in the present motor age where our urban life with its strident, insistent hurry has noise as a predominating feature. It is also true of our factories, and the current impressionistic drawings of industrial scenes should have their counterpart in weird, synthetic sound patterns symbolic of the "hum" of industry. We would expect an outsider viewing our civilization to conclude that there exists a squalor of noises in a world of mechanical splendors.

Within the past few years there have appeared signs of awakening consciousness. The first eager acceptance of mechanical appliances has been tempered by a demand for silent operation in a public reaction that has been reflected in engineering circles. The engineering version of this reaction is that with which I shall be concerned here. Because of it, such typical branches of engineering as civil, mechanical, and communication have had to turn their thoughts to a new field which may be called noise engineering.

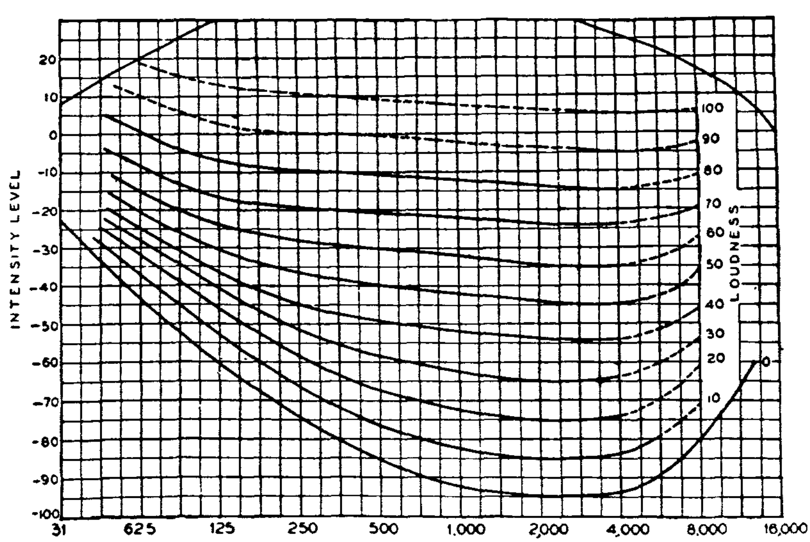
Noise engineering has to do with noise in all its phases; generation, transmission, effects on mechanical and human equipment, measurement, analysis, and suppression. It is both preventive and curative in its practice, the ultimate purpose being the elimination of all undesired noise and vibration. Some of the high lights of this new field will be discussed.

Noise we define as any undesired sound. This definition emphasizes the psychological rather than the purely physical



A. Pure Tone, 500 d.v.s.
B. Line Noise
C. Street Noise

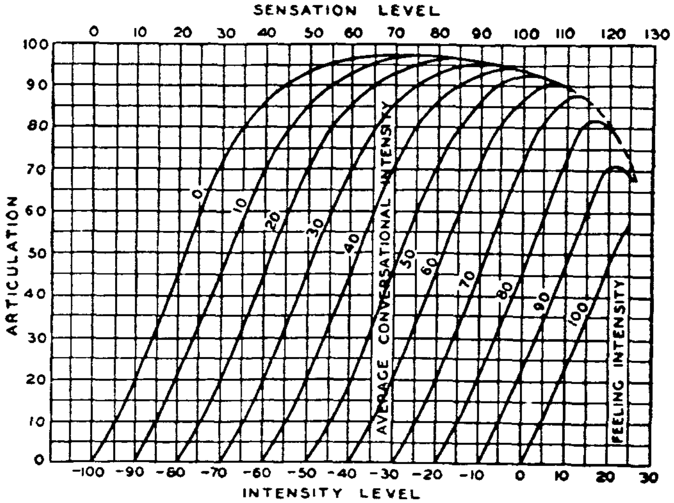
FIGURE 1



CONTOUR LINES OF EQUAL LOUDNESS FOR PURE TONES.

FIGURE 2

aspects, and correctly so. The physical properties of noise and music tones are very much the same in regard to measurement, transmission and absorption; hence distinction cannot be made too sharply. In Fig. 1 are shown three types of sound wave forms ranging from the simple pure tone to the highly complex street noise.



-Articulation vs. Intensity of Received Speech in the Presence of Noise.

FIGURE 3

Since we are concerned with the human elements in noise reduction work, it is necessary to examine briefly psychological and physiological effects of sounds. Subjective auditory response to sound stimuli is logarithmic in character; *i.e.*, the Weber-Fechner law of sensation which applies to the other senses is true for hearing also. There is some deviation from the logarithmic relation especially at the higher and lower frequencies, as the hearing mechanism is non-linear with intensity. It is also non-linear with frequency. The ear is a great deal more sensitive to low intensities from 1,000 to 4,000 cycles than it is at others. As the intensity is increased, the response with frequency becomes more uniform.

These facts are shown in the form of the Kingsbury equal loudness curves of Fig. 2 (Ref. 1).

In Fig. 3 is shown the effect of noise in auditoriums on the intelligibility of speech, in terms of articulation (Ref. 2).

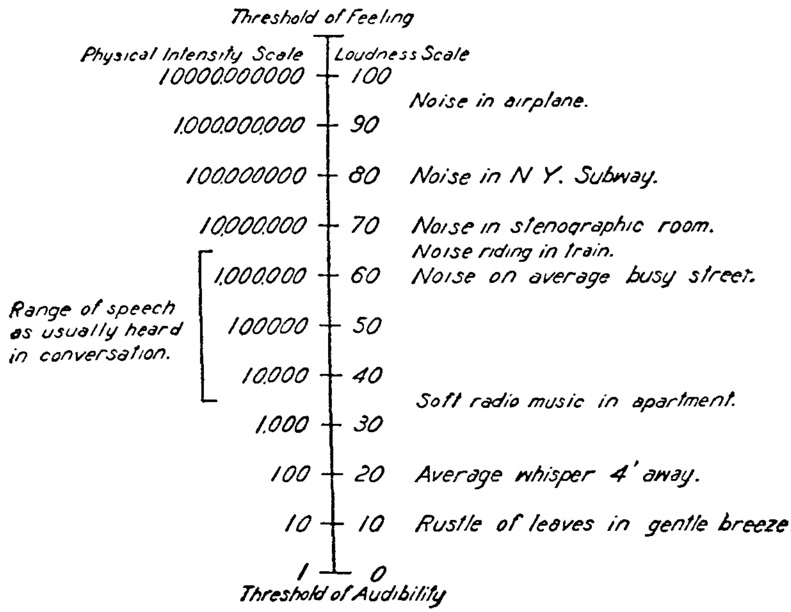


FIGURE 4

In addition to auditory sensation, noise also produces other less tangible effects. There are psychological elements like annoyance and mental fatigue; *e.g.*, it is thought that pure tones of high frequency are more annoying than pure tones of low frequency of equal loudness. Recent investigations have shown harmful physiological effects of noise on brain pressure, digestive system, body recovery during sleep etc. These consequences cannot be elaborated upon here, but the noise engineer must be familiar with them in order to determine what characteristics of undesired sounds require the most immediate attention.

Noise studies proceed most rapidly when measurement of noise is feasible. Sound meters are invaluable in eliminating

the human element and furnishing reliable data concerning the composition and magnitude of noise. Several types of instruments with novel design features have been devised,

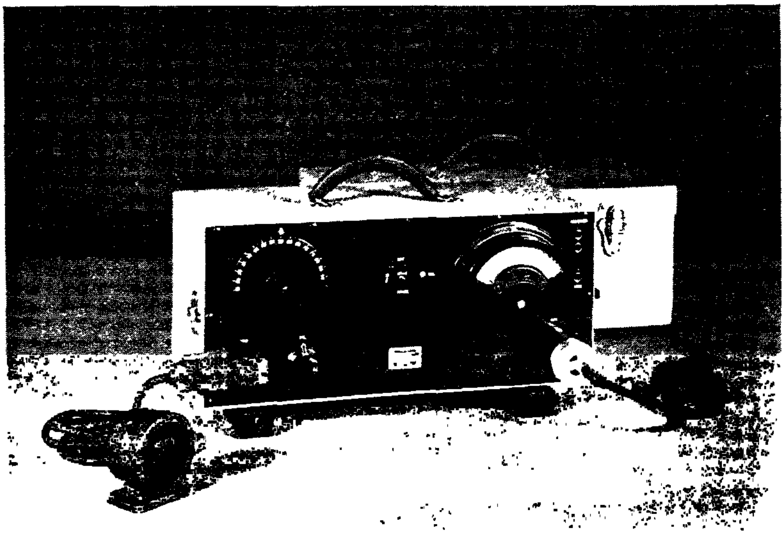
NOISE LEVELS OUT OF DOORS DUE TO VARIOUS NOISE SOURCES

SURVEY OF NEW YORK CITY NOISE ABATEMENT COMMISSION		NOISE LEVEL	OTHER SURVEYS	
DISTANCE FROM SOURCE	SOURCE OR DESCRIPTION OF NOISE		SOURCE OR DESCRIPTION OF NOISE	SURVEY NO
FEET		DB		
		130	THRESHOLD OF PAINFUL SOUND	4
		120		
2	HAMMER BLOWS ON STEEL PLATE-SOUND ALMOST PAINFUL (INDOOR TEST)		AIRPLANE; MOTOR 1600 RPM; 18 FT FROM PROPELLER	5
		110	AERO ENGINE UNSILENCED—10 FT	4
		100		
35	RIVETER			
15-20	ELEVATED ELECTRIC TRAIN ON OPEN STRUCTURE	90	PNEUMATIC DRILL-10FT	4
			NOISIEST SPOT AT NIAGARA FALLS	2
			HEAVY TRAFFIC WITH ELEVATED LINE, CHICAGO	7
15-75	VERY HEAVY STREET TRAFFIC WITH ELEVATED LINE	80		
15-50	AVERAGE MOTOR TRUCK		VERY NOISY STREET NY OR CHICAGO	1
15-75	BUSY STREET TRAFFIC	70	VERY BUSY TRAFFIC LONDON	4
15-50	AVERAGE AUTOMOBILE			
3	ORDINARY CONVERSATION			
15-300	RATHER QUIET RESIDENTIAL STREET, AFTERNOON	60	AVERAGE SHOPPING ST. CHICAGO	6
			BUSY TRAFFIC, LONDON	4
15-50	QUIET AUTOMOBILE	50	QUIET AUTOMOBILE, LONDON	4
	MINIMUM NOISE LEVELS ON STREET		QUIET ST BEHIND REGENT ST, LONDON	4
15-500	IN ENTIRE CITY DAY TIME — MIN AVERAGE			
50-500	IN ENTIRE CITY DAY TIME — MIN INSTANTANEOUS	40		
50-500	IN MID-CITY NIGHT — MIN INSTANTANEOUS			
		30	QUIET ST, EVENING, NO TRAFFIC SUBURBAN LONDON	4
		20	QUIET GARDEN, LONDON	4
			AVERAGE WHISPER -4FT	3
		10	QUIET WHISPER - 5 FT	4
			RUSTLE OF LEAVES IN GENTLE BREEZE	3
		0	THRESHOLD OF HEARING	

FIGURE 5

and they will be briefly mentioned here. The intensity may be measured either in dynes or the logarithmic unit, borrowed from the transmission engineer, the decibel. Some typical noise values are shown in Figs. 4 and 5 (taken from Refs. 3 and 4).

A comparatively simple meter is one designed to measure acoustic power directly. This type is not common inasmuch as usually we are concerned with the sensation value of a sound. A more common type of sound meter is shown in Fig. 6 (Ref. 5). This has a frequency weighting characteristic similar to the loudness level curve at 40 db shown in Fig. 2. To



simulate the ballistic characteristic of hearing, it is designed to give full response only for sounds of more than a fifth of a second duration. The maximum intensity for which it will function is about 500,000,000 times the minimum, an enormous range for an instrument, but not so great as our ears can accommodate. The ideal for this type of meter, complete correspondence between its readings and the response of the average human ear, is far from realization. Nevertheless, the instrument is most valuable in engineering studies on noise and noise reduction. The schematic diagram of a recording sound meter is shown in Fig. 7.

Another type of instrument is the harmonic analyzer.

Applied to noise, the name is something of a misnomer, for the meter will indicate components having no harmonic relation to each other. Such analysis is desirable to aid in locating the sources of troublesome components. The analysis may be broad; *i.e.*, the entire acoustic spectrum may be divided into three or four parts; or separation between com-

AUTOMATIC LEVEL RECORDER

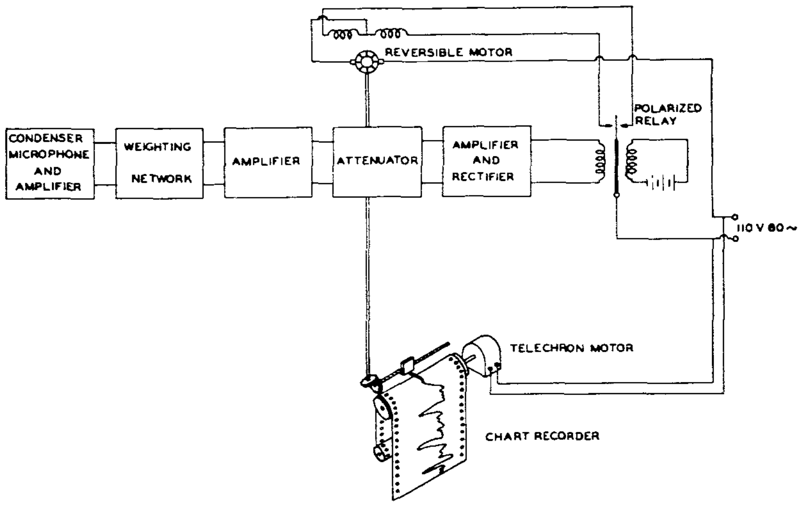


FIGURE 7

ponents relatively few cycles apart may be had. One type noise analyzer, developed by the Bell Telephone Laboratories, is shown in Fig. 8. This is based on the heterodyne principle in order to secure uniform and high selectivity with electrically resonant selector circuit. It is interesting to note that today mechanically resonant elements are sometimes employed in place of electrical circuits in such analyzers.

Since noise in modern life is, in one sense, largely due to the engineer, it seems fitting that the engineer should now concern himself with ameliorating existing conditions. The program adopted by the noise engineer to war on noise may be classified into fields related to the several branches of engineering. The first principle of the noise engineer, avoidance of its

generation, is highly applicable in other fields, mechanical engineering being the most prominent. If our machines can be made silent in operation, the first great step forward will be realized. Factories, offices, and homes even can be quietly peaceful compared to present conditions. The transportation fields offer great possibilities in this respect. Auto-

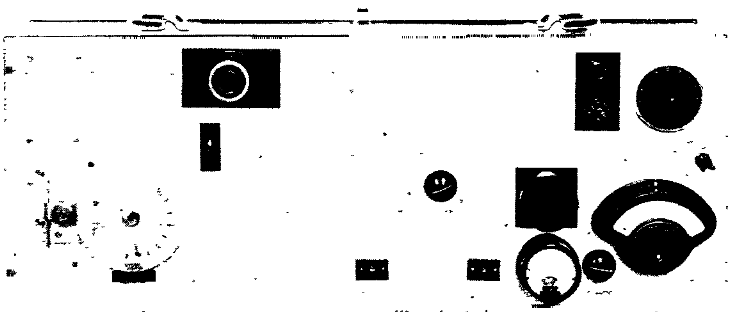


FIGURE 8

mobiles, subways, trolleys, and aeroplanes are all noisy, but are all undergoing study and improvement. The second principle of the noise engineer, to avoid sound and vibration transmission, is obviously important to the construction man and also to the mechanical engineer. It is the duty of architects and builders to supply substantial sound-proof buildings. To keep out noise, homes of the future may employ windows for light and observation only, air being obtained through auxiliary sound-proof inlets. The third principle, to absorb sound, has its application after other principles have been tried. The ventilating expert uses it to produce silent ventilating ducts and window attachments, and there are other

similar uses for diminishing the intensity and sensation value of noise.

How is the above program being carried out at the present time?

I feel that I am not being too optimistic when I say that progress is being made all along the line. Automotive engineers are giving us the silent second and vibrationless motors and motor suspensions. Recently in New York City the Board of Transportation had us perform for it an extensive noise survey of subway and elevated lines. The study included the consideration of the type of road-bed, type of tunnel construction, type of elevated structure, type of rolling stock, all with the thought that each link should be designed to achieve quiet conditions.

The noiseless typewriter is comparatively familiar to all but even it is undergoing modification to make it more silent. In talking picture work we have introduced the so-called noiseless recording to amputate the highly unnecessary scratch from film entertainment. Manufacturers of household equipment, such as electric refrigerators, have catered to the public demand by producing quiet machines.

And so on. I have tried to outline some engineering aspects of a large scale program for the elimination of noise. The program is an idealistic one but nevertheless admits of practical realization. As the parties directly responsible for bringing about improvements in material fields, engineers hold the fate of the program in their hands. They should realize the advantage of noise reduction in the way of increased comfort, health, and efficiency, and adopt as one of their fundamentals the precept of noise suppression.

References

1. Fletcher, H.: *Speech and Hearing*, D. Van Nostrand Co., New York, 1929, p. 230.
2. Fletcher, H.: Ibid., p. 298.
3. Aeronautics Bulletin No. 25, U. S. Dept. of Commerce, Washington, 1930.
4. Galt, R. H.: "Noise Out-of-Doors," *Jour. Acoust. Soc. Amer.*, 2, 1 (July 1930), p. 38.
5. Castner, Dietze, Stanton, and Tucker: "Indicating Meter for Measurement and Analysis of Noise," *Elec. Eng.*, 50, 5 (May 1931), p. 342.

WHY THE MARKINGS ON THE MOON'S SURFACE CANNOT BE OF VOLCANIC ORIGIN

By WILLIAM LEROY EMMET

(Read by title April 23, 1932)

THE knowledge which we can derive from an examination of the moon's surface is not alone interesting for its own sake but is highly important on account of its bearing upon the history of the solar system and upon conceptions as to the nature of the earth's formation, which in turn must form a basis for any correct reading of the geological records which its surface and rocks afford.

Many students of the moon's surface before and after the writer, whose first paper on the subject was written in 1907, have stated the opinion that these markings all resulted from bodies of various sizes falling into the moon in the ages of its growth, and it is some of the reasons which support this belief that this paper seeks to explain.

While there are doubtless various opinions on this subject in and out of the schools, it would appear that many of the persons who are considered most eminent in science entirely reject the theory above stated, and hold that the moon and earth were both born at or near their present size and were originally in a hot state, and that their present condition is the result of their gradual cooling with all the shrinkages, climate changes, and erosions which have gone on through long ages of which the duration has been estimated in various ways.

Among modern writers Jeans and Jeffreys express belief in Sir George Darwin's theory that the moon in the remote past was torn from the earth through the force of tidal vibrations which resonated with the rapid diurnal motion which he attributed to the system at that time. Such a theory implies a liquid or nearly liquid earth at that time and consequently

that both moon and earth began their separate lives in a hot and partially fluid condition.

Similar views concerning the original state of the earth seem to be held by the most prominent of the geologists, although the planetesimal theory of Chamberlain and Moulton seems to have developed some belief in an earth originally solid or solid long before it had reached its present size. Barrell describes an earth encased in a heavy atmosphere of water, vapor and other gases covering a surface of molten or dissolved rock.

As far as the writer has been able to observe most of the persons who are looked upon as the best authorities speak of the markings on the surface of the moon as of volcanic origin. Professor Chamberlain in one of his latest papers seeks to account for the formation from a disrupted sun of clots which formed the different individual planets and gives a theory why the moon should have become so intensely volcanic. If we accept the theory of a moon born full size from the earth as is done by Darwin and his followers, its markings must have been of its own making and can hardly be attributed to anything other than volcanic action.

The belief that it is here sought to explain is that the moon has never had a volcano or anything like one, that its internal temperatures have been presumably entirely unsuited to the production of such effects and that its markings have resulted simply and solely from its upbuilding by thousands of bodies which have been attracted into it from neighboring space, these bodies ranging in size from the smallest particles of which we can see evidence up to spheres of possibly 500 or more miles in diameter. The earlier of these arrivals have fallen into a cold and loosely laid and presumably light material and their acceleration, owing to the smallness of the body has not been sufficient to cause much fusion.

As might be expected under conditions where many bodies are growing by the attraction to them of smaller bodies, it appears that most of the larger bodies that entered the moon came relatively late because they have produced fusion and

viscosity by heat causing the areas so heated to flow or sink into flat plains, the so-called oceans and seas. These areas are sparsely marked by the pits of newer arrivals and consequently must be of relatively recent origin.

It may be that this theory of the moon does not differ very widely from that held by many scientists but it seems that little attention has been given to its obvious significance as an indication of what the earth's history must have been. If it is even approximately correct the whole science of geology as it is now taught should be in many ways changed. We would have in our rocks instead of the history of a gradually cooling earth, that of many successive earths, each a little larger than its predecessor, each with a presumable life of many millions of years, each with different climatic beginnings and cycles of change, each with a different diurnal motion and position of poles, and each with its own evolutionary history of fauna and flora only parts of which were shared with the worlds which preceded and succeeded it.

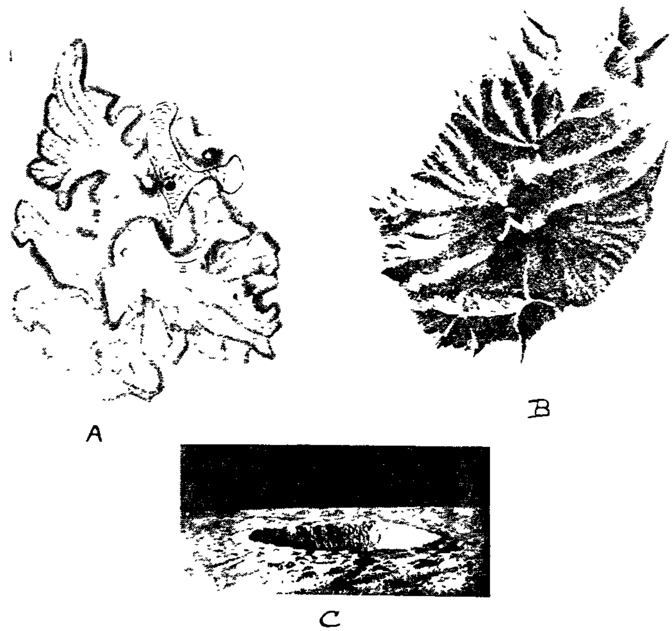
We will now take up the subject announced, namely, the reasons for believing that these markings are not volcanic, and will use some lunar photographs to illustrate the arguments.

Absence of Lava-built Masses with Elevated Craters.—Our only means of knowing what a volcano is like is to examine volcanoes on the earth and such studies have been often very carefully made. In Plate I, *A* and *B* are given cuts of two drawings taken from one of Dr. Henry Washington's papers. These cuts show what is common in volcanic growths, namely, one or more small craters generally in elevated positions surrounded by the evidences of repeated lava flows of various ages built up into more or less extensive mountain masses. On the moon there is nothing which bears the slightest resemblance to a lava flow or which can be in anyway associated with one, and there is not a single pit which might be called a crater which occupies an elevated position.

Great Size of Moon's Circular Markings.—A second reason for believing that these markings are not volcanic is their

great size, there are probably more than a hundred more than 25 miles in diameter. Volcanic craters are measured in yards

PLATE I



not in miles except possibly in a few cases where volcanoes have done what is called "blowing their heads off." A good idea of this can be found from Plate IV, which shows a rougher area of the moon where every part of the surface is made by or forms part of some kind of circular marking which circles overlap each other in an entirely arbitrary way and a large proportion of which are hundreds of times larger in area than any ordinary earthly craters.

Small Quantity of Material in Surrounding Ridges.—In none of the so-called moon craters is the quantity of material in the surrounding ridge nearly adequate to the making of such a hole. Many of the smaller markings in smooth areas are simply pits thrust into the surface to some depth with hardly any surrounding ridge and that smooth and even in

character and hardly high enough to cast a shadow. See *A*, Plate III.

PLATE IV

The only crater in any way similar to the moon markings which we know on earth is shown by the aërial photograph, Plate I, *C*, and this we know is not volcanic. This crater known as Coon Butte in Arizona is known to have

been made by a large metiorite which happened to fall in relatively recent times into a level plain of bedded sandstone. While its conditions are very different from any thing on the

PLATE III

moon it is very much more like the moon's markings than is any terrestrial volcano and is therefore highly suggestive.

Smooth Areas Caused by Fusion.—If the smooth areas of

the moon are examined it will be seen that large portions of them at least have been rendered flat and smooth by heat from within which has rendered the material partially fluid

PLATE II

or viscous so that objects that stood above the surface at one time have sunk into it. The faint circles marked *A* on Plate II have undoubtedly been pits or so-called craters like

the rest, but viscosity of the material below them has caused the walls to sink until they have almost disappeared. In several other places on the moon there are such circular markings which look like no more than stains, the ridges having become quite flat.

The craters marked *B* on Plate III have been subjected to a less heat from below and their walls have only partly sunk so that the floor inside is flat and at the level of the smooth surrounding plain.

There are other evidences of such sinkings of prominences of a time before viscosity began and which have sunk into the border regions of the smooth areas and such conditions show that these smooth areas were not simply struck down by the impact of large spherical bodies but that the heat of such impacts in some cases spread for some distance into the surroundings. Or perhaps the larger bodies sometimes came in somewhat inclined to the surface and carried heat diagonally down and under the margins of the hole of entry.

Such effects could be produced by nothing but fusion and it is impossible to conceive of a body starting hot and gradually cooling with incidental volcanic effects, showing such late date fusion in some places and complete absence of it in such others as the very rough areas.

Segments of Ridges Evidently Caused by Large Bodies.—Plate III shows at *C* a curved ridge evidently marking part of the boundary of the place where a body of approximately 150 miles in diameter entered, and there are other curved boundaries with heavy splashing of material beside them which probably have similar origin. The area which has been known as Mare Cresium is almost round and surrounded by rough surface. A body of perhaps 200 miles in diameter must have entered here and the heat and fusion have spread a little into the surroundings so that the circle is a little distorted. A glance at many of the dark areas on a small scale photograph shows that they have approximately circular form, much too near circles to be matters of chance.

Earth Volcanoes Confined to a Few Regions.—There are

only a few volcanic regions in the earth, generally in chains of mountains near the sea. On the moon the scattering of so-called craters is arbitrary. In fact they are thickly clustered everywhere except where they have been obliterated by fusion in the smooth dark areas and in these areas the evidence of such fusion is indisputable.

The rough areas of the moon as shown by Plate IV have very interesting characteristics. They are much lighter in color than the smooth areas. This suggests that they are built of relatively light combined material possibly not in a completely consolidated state, while that in the smooth areas has been consolidated and perhaps partly smelted by heat so that it has become heavy and dark like basalt.

The older and larger pits in these rough areas have more or less rounded edges while the pits in smooth areas which have been made since the surfaces cooled are quite sharp in detail. The older pits in the rough areas look as if they might at one time have been subject to some erosion but there is no sign of a water course, although it has been suggested that there may be some water or snow or at least water vapor on the dark side of the moon.

These rough areas look just as they should look if they had been built through ages by the arrival of thousands of bodies from outer space arriving under the influences of a relatively small force of gravity and the writer believes that when these surfaces were built the moon was very appreciably smaller than it now is.

There are other evidences of impact growth on the moon's surface. In some places large quantities of material seem to have been splashed over the surface apparently from impacts, possibly at angles inclined to the surface, of large bodies which have thrown material horizontally across certain parts of the surface and have also forced up great ridges. We also find very positive evidence of an impact in the crater named Tycho. Here a body probably of light and weak material or possibly a loosely knit ball of such material has broken up on impact with a surface of the moon which had been pre-

viously solidified by fusion. The velocities resultant from the initial velocity and the break up have thrown parts of this material a thousand miles, the vacuous atmosphere and low gravity accounting for the great distance. Nothing but a scattering of solid matter could make such a mark.

If from such facts and arguments as are here given it is decided that the markings on the moon are not of volcanic origin, it is obvious that some other explanation should be sought, and any explanation other than the impact theory seems difficult to conceive. If we accept the impact theory a wide vista of results and possibilities is opened which extends to the earth and the other planets and to the cosmogony of the solar system. The establishment of such a fact therefore would afford a valuable starting point for astronomers and geologists.

THE EFFECT OF ETHYLENE UPON LIVING ORGANISMS

By WILLIAM CROCKER

(*Read April 23, 1932*)

SINCE 1908 when Crocker and Knight, of the University of Chicago, answered the florist's question, "How does illuminating gas affect carnations?" by showing that 1 part of illuminating gas to 80,000 of air put the carnation flower permanently to sleep within 12 hours and that ethylene was the effective constituent with 1 part in about 2,500,000 of air, the minimal effective dosage, the effect of ethylene on living organisms has received much attention in the United States. Such low concentrations of ethylene in the air could not be detected by any chemical means known so these two investigators undertook to find plants that were very sensitive to ethylene and gave specific and unmistakable responses to it. The etiolated sweet pea seedling proved to such a plant giving the response in 1 part of ethylene to 10,000,000 of air. Later, in the same laboratory, E. M. Harvey showed that the castor bean plant responded specifically to the same low concentration of ethylene by epinastic growth of the petioles, that is, growth on the upper sides of the petioles which turned the leaves downward. Still later, in the same laboratory, Doubt showed that the petioles of a number of different plants (tomato, Salvia, Datura, and others) showed marked petiole epinasty in concentrations of ethylene as low as 1 part to 10,000,000 of air. Doubt showed that ethylene acted as a stimulus to plants inducing besides petiole epinasty other physiological changes such as leaf fall, proliferation of various tissues involving both hypertrophy and hyperplasia. She also found that it acted as an anaesthetic producing growth rigor in various plants. E. M. Harvey studied the chemical changes that ethylene induced in the sweet pea seedling and found that the changes induced were typical of such anaesthetics as ether.

In 1923 Dr. Arno B. Luckhart of the University of Chicago, extending the studies to animals, discovered that ethylene is an excellent anaesthetic when applied in concentrations of 80 to 85 per cent with oxygen as the residual gas. Since his discovery, ethylene has gradually come into more general use as an anæsthetic for major operations. The patient recovers readily without ill effects such as nausea and belching so common with ether. It has little effect upon the heart and is, therefore, especially desirable for goiter operations or other operations where the heart is weak or disturbed in action. It has great promise as an anæsthetic in surgery.

For years muffled oil stoves were burned in citrus storehouses for yellowing the fruits. In 1913 it was proved that these stoves did not favor yellowing by increasing the temperature but that some incomplete combustion product due to the muffle was the effective agent. In 1923 Dr. F. E. Denny showed that ethylene used in high dilutions, 1 part to 5000 of air to 1 part to 1,000,000, caused the rapid yellowing of citrus fruits. Ethylene is probably the effective chemical produced by the muffled stoves. The citrus industry rapidly substituted the gas for the stoves. Since that time other workers have found ethylene effective in ripening a number of other fruits.

The many demands for information on the effect of illuminating gas on greenhouse plants and trees in connection with losses from this source has led Zimmerman, Hitchcock, and the writer, at Boyce Thompson Institute for Plant Research, to study in great detail the effect of illuminating gas, its constituents, as well as many other gases on about 250 species and varieties of plants. These studies have shown that there is a great variation in the sensitiveness of different sorts of plants to ethylene; the Boston fern was not injured when it was kept in 90 per cent ethylene for many days while several plants showed petiole epinasty in 1 part of ethylene in 20,000,000 of air. The most general effect of ethylene was reduction of rate of elongation of the plants. It had a very similar effect on a given plant over a very wide range of concentrations showing

low toxic action and high anæsthetic or rigor-producing action. It caused decomposition of chlorophyll in roses starting with the midrib of the leaflets, followed by main side veins and finally by the whole leaf. It induced leaf abscission in many plants. It never burns foliage in any concentrations as do highly toxic gases like sulphur dioxide or ammonia.

Since petiole epinasty is an excellent and an extremely sensitive test for ethylene, these investigators have made a detailed study of this reaction especially in the tomato, one of the best test plants. Out of 202 species or varieties of plants tested, 89 showed petiole epinasty with ethylene and 113 did not. The epinasty in tomato leaves was brought about by the ethylene inducing growth on the upper side of the petiole, even in old petioles that had ceased to grow. The younger petioles recover completely their normal position after removal from gas, the medium aged ones to a great degree, and old ones show little recovery. Motion pictures of plants in air and in ethylene-air mixture showed that ethylene stopped the normal growth movements of sunflower and tomato plants and induced growth on the upper sides of the petioles where growth had ceased. It acted as an anæsthetic in the first instance and as a stimulant in the second. Out of 39 gases tested on the tomato plants, including many constituents of illuminating gas, alcohols, aldehydes, anæsthetics, etc., only 5 induced leaf epinasty. They are as follows with the minimal concentrations in parts per million of air necessary to induce the epinasty: ethylene 0.1, acetylene and propylene 50, carbon monoxide 500, and butylene 50,000. These are all unsaturated carbon gases. No saturated carbon gases tried induced epinasty. In the olefine series (ethylene, propylene, and butylene) as the figures above show, the effectiveness fell rapidly as the number of carbon atoms in the chain increased. Ethylene was 500 times as effective in inducing petiole epinasty as the next most effective gases (acetylene and propylene) and 5000 times as effective as carbon monoxide.

Ethylene-induced epinasty of petioles was shown to be intimately tied up with the orientation of the petioles to the

direction of the pull of gravity. Ethylene was most effective in inducing epinasty when the plants were upright or the lower sides of the petioles faced the earth; it was only about 0.4 as effective when the plants were rotated on a horizontal clinostat; and only slightly, or not at all, effective when the plants were inverted or the upper sides of the petioles faced the earth. Excised leaves behave in the same manner as they do when attached to the plant. The response of each petiole is independent of the rest of the plant. It is certain that ethylene does not act directly in inducing epinasty of petioles but that it acts indirectly, probably by modifying the equilibrium position of the petiole with gravity, as shown by Neljubow for the pea and other legume seedlings.

In upright plants exposed to ethylene the petioles bent downward with a force equal to four to eight times the weight of the leaf.

The epinastic response of tomato petioles makes an extremely delicate test for ethylene and, since carbon monoxide is usually associated with ethylene, indirectly for carbon monoxide. It may be used for testing for unsaturated carbon gases in mines, garages, greenhouses, submarines, living rooms, or any other place desired. The tomato test is always many hundred or, in some gas mixtures, thousand times as sensitive as the canary. The question whether natural gases contain olefines, unsaturated hydrocarbons, has long been under dispute. The tomato plant showed that natural gas from Charleston, West Virginia, the only sample available, contained 0.001 of 1 per cent of ethylene, a concentration too low to be detected by ordinary chemical methods.

From what has been said above, one is justified in stating that ethylene is one of the most remarkable, if not the most remarkable, simple chemical compound known in respect to its physiological effects on plants and animals.

THE PNEUMATIC SYSTEM OF TREES

By D. T. MACDOUGAL

(Read April 23, 1932)

THE gases which occupy the spaces in the non-living elements of trees have been found to have a volume at barometric pressures equivalent to about two to four tenths of the total volume of the trunk, in the few instances in which determinations have been made.

These gases fill all woody cells and spaces not occupied by the filaments of the meshwork of sap.

The hydrostatic system of trees mostly occupies the woody cells of the layers formed during the preceding three or four years in coniferous trees, while in other species a part of every layer conducts sap. Whatever the configuration of the continuous meshwork of liquid in the woody tissue it connects directly with the sap of the living cells in the roots and extends without break to the living cells in ventilated leaf-interiors. Here the loss of particles of water-vapor from the curved surfaces of the termini of ultra-microscopic surfaces sets in action the forces of surface tension which may exert a pull of 200 atmospheres on the meshwork of water extending downward through the stem and the roots and connecting directly with the water in the soil. The restoration of the curved surface of the liquid in moist cell-walls, deformed by the loss of water-particles is the prime mover which raises sap to the tops of trees.[1]

The gases in a tree trunk and the sap occupy vessels and woodcells in trunks in close contiguity so arranged that the pneumatic and hydrostatic meshworks which are formed interlock. Despite the fact that gases and liquids may occupy

[1] MacDougal, D. T., *The Hydrostatic System of Trees*, Publ. 373. Carnegie Institution of Washington, 1926.

neighboring cavities, tensions or changes in one appear to have a very small effect on the other.

This obvious fact is totally ignored in all discussions of sap pressures, excretion, root-pressure and movements of sap. The experimental practice of the present day continues the use of liquid-filled manometers attached to stumps of stems and bores in trunks after the manner Hales described in his Vegetable Staticks more than two centuries ago (1727).

When a bore is driven into a tree-trunk and filled with water, the liquid fuses with the sap stream in numberless places and is drawn into gas-filled vessels by capillarity, with some gases going into solution. The readings of a manometer connected to such a complex cannot be reliably interpreted except in the light of collateral information not readily available. Such readings are usually designated as *positive* and *negative* sap pressures.

The tensions recorded are the resultant of so many conditions as to render such terms false and delusive. Research and instruction would advantage greatly if the sections of books dealing with experiments of this kind could be eliminated entirely or clearly set out as of historical interest only.

The principal features of the conditions of the gases to the liquids in a tree-trunk may be set forth as follows:

First, the gases occupy vessels and woody cells in irregular tracts which are in contact with tracts conducting sap. Wherever gases are in contact with such moist walls, solution and diffusion of the gaseous elements result. The filaments of sap when under high stretching tension or temperature would have a reduced solution capacity. At lower tensions or under pressure and lower temperature solubility would be increased at rates specific to oxygen, carbon dioxide or nitrogen, the gases almost exclusively involved.

Secondly, the gases enclosed in a tree trunk may in addition to diffusive transference through liquids move through spaces and perforations very freely in a longitudinal direction in trunks, and less freely in a radial direction in communication with the external air.

The author in collaboration with Professors J. B. Overton and G. M. Smith has carried out tests with both steam and air pressure which show that alterations equivalent to 1 to 3 atmospheres in pressure may be communicated to distances of a few meters, and beyond the length of open vessels within one minute in the willow. Ready communication was demonstrated in oaks and other trees.[1]

In consequence of this freedom of movement, gases liberated and passing into the pneumatic system may be quickly carried by streaming to distant parts of the shoot. Radial communication of the pneumatic system are of much smaller dimensions and are probably highly specific in trees of different species. It is also probable that these communications vary throughout the season in any tree.

Such communications may be through passages not yet demonstrated microscopically. The passages are of such dimensions that while gases may pass by streaming, watery solutions may not at pressures of one to three atmospheres.

The pressures under which gases are found in tree trunks generally do not vary more than the equivalent of 15 to 20 mm. Hg from that of the outside air. Some results published in 1926 showed gas pressures in Juglans, Quercus and Pinus less than barometric.[2] Higher pressures have been found in such trees as Juglans under autumnal conditions. This state of affairs is attributed to the trapping or complete enclosure of a tract of gas-filled elements by layers of cells filled with sap by excretion from living osmotically active cells. Two series of measurements of the tension in the pneumatic system were made early in 1932.

A manometer was securely sealed to a radial bore 12 cm. deep in a tree of Quercus agrifolia at Carmel at the end of January 1932. The bore and the connecting tube contained

[1] MacDougal, Overton and Smith, *The Hydrostatic-Pneumatic System of Certain Trees: Movements of Liquids and Gases*, Publ. 397. Carnegie Institution of Washington, 1929. See also Yearbooks, Carnegie Institution of Washington, No. 26, p. 162, 1927; No. 27, 1928; and No. 28, p. 166, 1929.

[2] MacDougal., D. T., *The Hydrostatic System of Trees*, Pub. 373. Carnegie Inst. of Wash., 1926, p. 123.

air only. The instrument consisted of a U tube filled with mercury. The registered differences in level of the mercury in the two arms were taken as indicative of the pressure in the gaseous system of the tree.

On March 28th the records showed a maximum of 9 mm. Hg. above barometric and a minimum of 4 mm. Hg. below. On a large number of clear warm days pressures below barometric were registered in early morning at the time of lowest temperature, lowest transpiration, and greatest daily expansion of the tree; and pressures above barometric were registered in the afternoon with the above features reversed.

A test of the same kind was made with a Populus of similar size at the Desert Laboratory. The variations in pressures of the pneumatic system were recorded for the period beginning early in February and continuing until March 5. So long as the instrument was connected directly with the gas body of the tree only pressures varying from 7 mm. Hg. less than barometric to 5 mm. greater were registered.

As the pressures above barometric in both the oak and poplar occurred concurrently with the daily shrinkage of the trunks due to increased transpiration a direct connection may be inferred. The reversible daily contraction of a tree which may vary from 1/100 to 1/1200 of its volume would be sufficient to cause this alteration in the pressure of its enclosed gases.

Late in February hydrolysis of stored starches set up an excretory action which filled the bore connected to the manometer after which positive hydrostatic pressures occurring beyond 100 mm. Hg.—the range of the instrument—were registered in Populus.

The apparent beginning of similar hydrostatic action of the oak at Carmel was seen at the end of March.

The fact that the pneumatic system of trees which is interwoven with the hydrostatic meshwork in which the liquid is moving constantly but at a varying rate toward the summit of trees constitutes a major feature of great importance. Gases are doubtless passing into these liquids by solution

from the pneumatic system or being released into it from the sap. The accumulations of gases in the woody cylinder of trees and are enclosed by the completely sheathing cambium layer. In Carnegiea, however, gases of the external or cortical layer were taken.

Samples for analysis were obtained from bores 1 cm. in diameter driven radially 12 to 15 cm. toward the centers of trunks. A threaded bronze tap would be screwed into each freshly bored hole, after which a gas receiver of a capacity of 10 to 200 cc. would be connected to the free end. A bulb of heavy glass of a capacity greater than that of the receiver filled with mercury was connected with the free end of the receiver by a half-meter length of rubber pressure tubing.

All joints were securely sealed and the rubber tubing covered with shellac or varnish to prevent diffusion of gasses.

Relief stopcocks were included in the system so that the gas receiver could be cleared of atmospheric air. After this was done the bulb of mercury was placed at a level at which a suction of about 300 mm. Hg. was exerted in the bore. A greater suction might draw atmospheric gases in through the cambium layer which would vitiate the sample.

The first measurements of the present series were made in 1925. Numerous samples have been taken in every year since that date, the general series being brought to a close in 1931. It is to be noted that the trees, the gases of which were studied, were native to the coastal region at Carmel, California, with an equable climate, or to the desert region or mountains near the Desert Laboratory, at Tucson, Arizona. The species studied included *Pinus radiata*, *Quercus radiata*, *Salix lasiolepis*, *Juglans major*, *Sequoia sempervirens*, *Parkinsonia microphylla*, *Populus macdougallii* and *Carnegiea gigantea*.

The earliest observations on the gases enclosed in plants may be attributed to Ingenhousz, who in 1788 published the fact that the proportion of oxygen in green seed-pods might be greater than in the air. Some additional figures were brought out by Saussure in 1821, Bischoff in 1829, Dutrochet in 1837,

Aimeé in 1841, Gardner in 1846, Erdmann in 1855, Baudrimant in 1855, Martin in 1866, Faivre and Dupré in 1866, St. Pierre and Magnien in 1876, Joulin in 1881, Krutigky in 1888, Wille in 1889, Peyran in 1891, Devaux in 1891, Aubert in 1891, and Pappenheim in 1892. Langdon and Gailey made a special investigation of the gases in the bladders of Nereocystis and found notable proportions of carbon monoxide which fact was reported in 1917 and 1920. Gerber reported a low proportion oxygen in the gases from fleshy fruits in 1896.

The high proportions of oxygen in green organs such as seedpods, or the leaves and stems of succulents are readily explainable by reference to photosynthetic activities. Other structures such as carrots, the roots of Nuphar and other thickened storage organs, the included gases of which generally show a smaller proportion of oxygen and a higher proportion of carbon dioxide than the air carry much greater interest in the present connection. This material may perhaps furnish the most favorable material for the study of the origin of carbon dioxide and the use of oxygen in what is generally designated as respiration.

The accumulations in tree-trunks may be affected by gases from maturing cellulose walls and other sources. Its composition is also doubtless modified by exchanges with the sap system.

The detailed results of several hundred analyses will be given in a paper now in preparation in collaboration with Professor E. B. Working. Some of the more prominent features are described below.

In contrast to the gases which may be found in cavities of photosynthetic organs, the accumulated gases in woody stems practically at all times include a much higher proportion of carbon dioxide than is found in the atmosphere. The general range is from 10 parts in a thousand to 260 parts in a thousand as contrasted with the 3 to 4 parts in a thousand of common air.

The evidence which cannot be adequately presented here seems to indicate that this great volume originates chiefly by

respiration of living cells. A further study of the seasonal variations may yield determinative evidence.

The oxygen in the tree never exceeds atmospheric proportions and varies chiefly between 100 and 200 parts in a thousand, although not found in some samples. It constitutes about 206 parts in a thousand in common air.

Nitrogen which constitutes about 780 parts in a thousand of common air varies from 770 to 830 parts in the gases of trees.

Terpenes have been recognized as one of the volatile substances suspended in the accumulated gases.

Carbon monoxide found by Langdon and Gailey as normally present in the bladders of Kelp (Nereocystis) has not yet appeared in analyses of tree gases.

Marsh-gas or any other inflammable gas has not yet been found in normal trees, although many reliable records of such substances as a result of internal decaying tracts are available.

General Considerations

As a result of a general survey of the hydrostatic and pneumatic systems of trees it has been found that the stretching tensions in the filaments of water of the first are affected but little by the pressures of the gases of the second.

The watery solutions or the sap may be under a positive, or excretory pressure of 5 to 8 atmospheres in tracts of the conducting system at certain times in the season's activity. During the greater part of the time the threads of sap in vessels and other woody cells is under a stretching tension which may be as great as 200 atmospheres.

Gases of the pneumatic system occur generally at pressures not widely different from barometric. The anatomical structures in which the gases are held allow rapid streaming up or down the tree and have a porosity that allows a radial, inward or outward streaming under pressures of a half atmosphere more or less.

Pressures in the pneumatic system become greatest during the daily period of greatest transpiration. This may be due

to the fact that the loss of water from the leaves or other surfaces sets up a stretching tension in the hydrostatic system which causes a contraction of the woody cylinder of the trunk. The shrinkage may be as little as one in a thousand or as much as one part in a hundred of the diameter.

This contraction would compress the gases and tend to accelerate exhalation. The reverse action would take place at night. Changes in barometric pressure would set up similar streaming exchanges between the air and gases enclosed in tree trunks. All variations in pressure and temperature will, of course, affect the solubility of the gases in the sap. As the watery solutions from the soil move upward through the conduits in the non-living woody cells, the moist walls of these elements are in contact with the gases of the adjoining elements. The gases would be dissolved and diffuse through the walls into the sap streams. Opportunity would thus be afforded for the absorption and transportation of carbon dioxide, which is present in much higher proportions than in the air, to the leaves where it would be freed with the vaporization of the water or be available in the sap as material for the photosynthetic processes. No statement may be made as to the amount actually used in this program. Whatever this may be, a movement is implied whereby carbon dioxide set free in a distant part of the plant is carried to the photosynthetic mechanism, where it may again be included in the metabolic cycle.

The composition of the accumulated gases has another feature of interest in those trees in which deeply imbedded ray and parenchyma cells are surrounded by elements containing these gases. The endurance of these living cells for centuries may be conditioned by the fact that they are continuously in an atmosphere containing from four to fifty times as much carbon dioxide as common air, and that their sap must at all times be saturated with this gas, while the proportion of oxygen is much less than in the air.

Summary

1. The gases in the non-living woody cells of trees may amount to 0.2 to 0.4 of the volume of the tree at barometric pressure.

2. The gas-filled elements constitute a meshwork through which variations in pressure may be quickly communicated and equalized.

3. The gas meshwork is surrounded by the cambium layer. Diffusion in the water of moist walls is continuous. Radial streaming movements into and out of the trunk may be caused by pressures of less than half an atmosphere.

4. The passages through which mass movements of gas may take place will not permit the streaming of water under pressures equivalent to or greater than those which are sufficient to cause movements of gas.

5. Variations in tension of the system gaseous exerts no measurable change in hydrostatic system.

6. Variations in tension in hydrostatic system causes contraction of woody cylinder of trees, with accompanying or resultant increased pressure of the enclosed gases.

7. Gases enclosed in tree trunks are generally at pressures between 9 or 10 mm. Hg. below or an equal amount above barometric pressures.

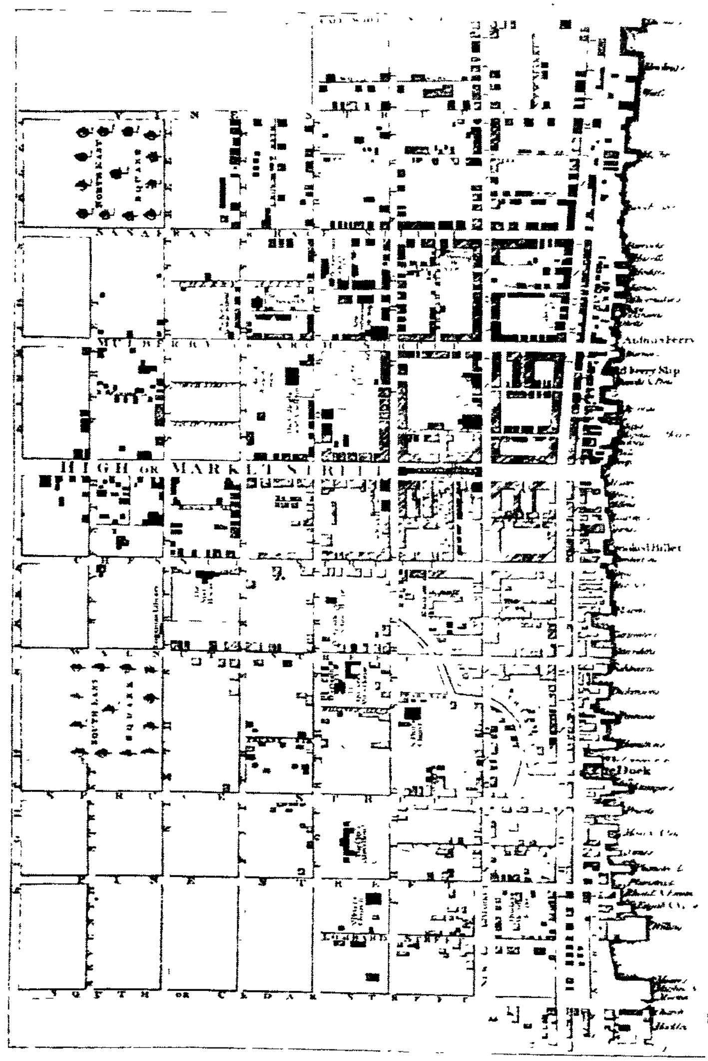
8. Several hundred samples of gases extracted from Pinus, Salix, Quercus, Juglans, Sequoia, Parkinsonia, Populus, and Carnegiea were analyzed in a seven-year period beginning in 1925.

9. Only atmospheric gases and terpenes have been found in samples from trees of the genera listed above.

10. Carbon dioxide which occurs as 3 to 4 parts in a thousand in the air generally constitutes 10 to 260 parts of the gases in trunks.

11. Oxygen which forms about 206 parts in a thousand of free air is most often found as making up 10 to 200 parts of tree gases. Some samples free of oxygen have been extracted.

12. The carbon dioxide accumulating in the gas meshwork of trees, may become dissolved in sap and be carried to the leaves where it would be available in the photosynthetic processes.



PHILADELPHIA, FROM A MAP MADE IN 1762 BY MATTHEW CLARKSON AND M. BIDDLE

"As Surveyed by the late Nicholas Scull."

From a print in Philadelphia. A History of the City with its People, by Ellis P. Oberholtzer, Ph.D., Vol. 1, p. 216.

THE ACTIVITIES OF MEMBERS OF THE AMERICAN PHILOSOPHICAL SOCIETY IN THE EARLY HISTORY OF THE PHILADELPHIA ALMSHOUSE (THE PHILADELPHIA GENERAL HOSPITAL)

By ROBERT J. HUNTER

(*Read April 22, 1932*)

In commemoration of the Celebration at the new Philadelphia General Hospital of the Two Hundredth Anniversary of the Philadelphia Almshouse.

THE Philadelphia General Hospital is a direct descendant and outgrowth of the Philadelphia Almshouse which originated at about the same time as the American Philosophical Society. I note in the transactions of the American Philosophical Society [1] that it was only after very careful research, the result of many years of labor, that the American Philosophical Society was finally able to set the date of origin at 1727. I also note with interest that you took as a criterion for the date of origin the dictum of the Carnegie Foundation defining a date of founding. By date of founding, it declared, "is meant the year in which the institution was established out of which the present college or university has developed." [2]

A bill to establish an Almshouse was passed in 1713 but we have no evidence that it was built. In 1728 the Assembly of the Province of Pennsylvania appropriated money for an Almshouse which was built in 1731 or 1732. An appropriation of £1000 was made by the Assembly for the Almshouse before an appropriation of £2000 was made for a House for the Freemen, now known as Independence Hall.[3] Thus the Philadelphia Almshouse began possibly in 1713, certainly in 1728 and was proposed before Independence Hall was built.

[1] Report of Charlemagne Tower, *Transactions American Philosophical Society*, 1910.

[2] Carnegie Foundation, Second Annual Report of the Pres. and Treas., p. 18, 1907.

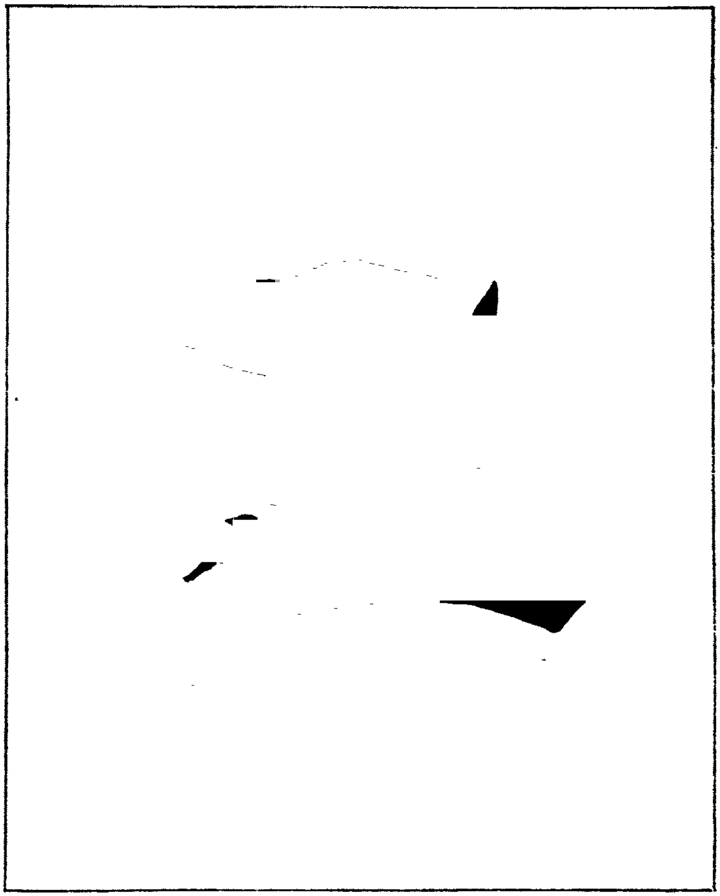
[3] Statutes at Large of Penna. from 1682 to 1801, Vol. V. Library, Historical Society of Pennsylvania.

Very little is known of this Almshouse, which was erected between 3d and 4th, Spruce and Pine Sts. No picture of this building has come down to us, but the location is shown on the Map of Philadelphia published in 1762 by Matthew Clarkson and an associate.[1] The city soon grew up to this block and the buildings became crowded and in 1766 steps were taken to move to the suburbs. A plot was bought from 9th to 11th, Spruce to Pine Sts. where the new Almshouse known as the Philadelphia Almshouse and House of Employment was erected in 1766 and occupied in 1767.

On looking into the question of how many members of the American Philosophical Society were connected with the Almshouse, the list grew so large that it seemed unnecessary to try to make it complete. In fact the men interested in founding the Almshouse and in its Management and on the Staff were almost universally members of the American Philosophical Society.

In 1766 the law had recently been changed to put the Almshouse under the care of "The Contributors to the Relief and Employment of the Poor etc." The contributors were to meet and elect managers who should actively conduct the business of the institution. Thus we find that on the 12th of May 1766 a number of the contributors met at the Court House and chose 12 managers and a treasurer of whom Joseph Fox received the highest number of votes; Philip Syng and Abel James next following, with Hugh Roberts and Samuel Rhoades. The minute is certified by Henry Drinker. The Managers received from the Overseers of the Poor the money raised by taxes, in addition to that received from the contributors. Among the latter in 1766 were: Samuel Preston Moore, M.D., John Redman, M.D., Isaac Paschall, Joseph Paschall, George Bryan, William Henry, George Clymer, John Dickinson, Samuel Purviance, Jr., John Morgan, M.D., Joseph Richardson, Philip Syng, William Logan, Esq., and Joshua Howell, Esq. They imme-

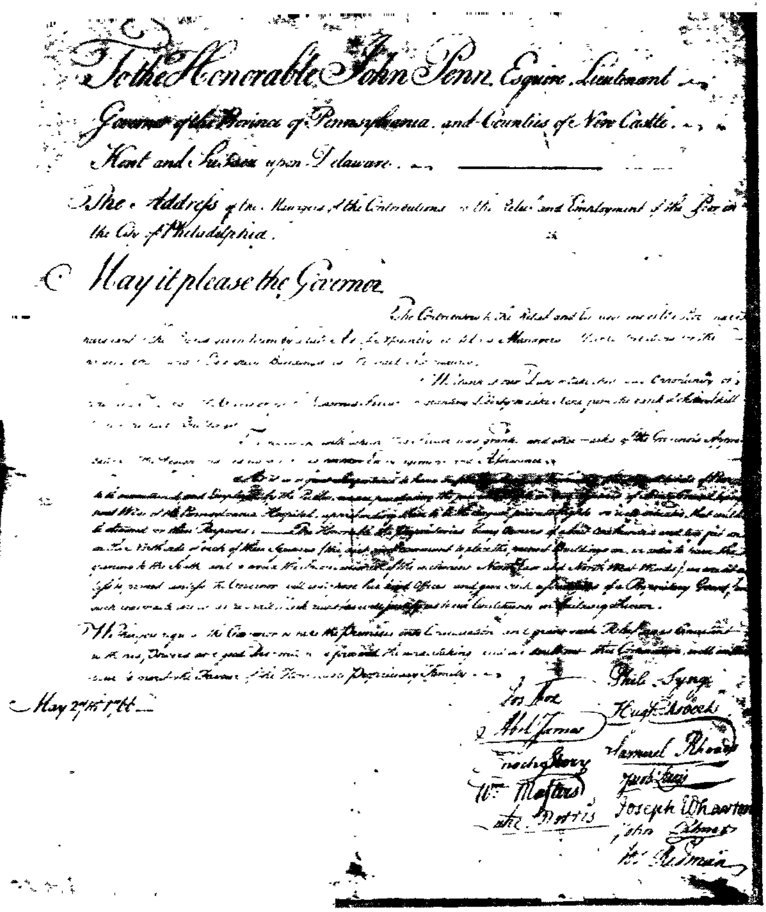
[1] At Library Co. of Philadelphia—Ridgway Branch. Map of Philadelphia in 1762 by Matthew Clarkson and Mary Biddle, as surveyed by the late Nicholas Scull.



· JOSHUA · HOWELL ·

Copy of a Silhouette from the collection of the Historical Society of Pennsylvania. Joshua Howell was a Contributor to the Relief and Employment of the Poor, etc. (The Philadelphia Almshouse) in 1766. His name appears repeatedly as a magistrate in the old records at the Philadelphia General Hospital.

diately proceeded to business, viewed the land, discussed the best place to dig the well, how the buildings had better be placed and assigned committees to take care of the different projects such as obtaining stock, getting glass from England, arranging for carpenters and building construction. Robert Smith, noted as an architect in the list of members of the American Philosophical Society, together with David Evans, was instructed to see that the work was done "agreeable to


To the Honorable John Penn Esquire Lieutenant Governor of the Province of Pennsylvania and Counties of New Castle, Kent and Sussex upon Delaware.

The Address of the Managers of the Contributions for the Relief and Employment of the Poor in the City of Philadelphia.

May it please the Governor

[illegible]

Petition of the Managers of the Philadelphia Almshouse and House of Employment to John Penn, May 21, 1766.

the plan." Abel James was "desired to import the window glass Taylors' make 8″ x 10″ half boxes packed in sawdust or bran." Joseph Fox drew an order on the Treasurer for £4/5 for lime and was to purchase the shingles.

On May 21, 1766 the Managers addressed the Hon. John Penn, Esq., Lieutenant Governor of the Province of Pennsylvania and Counties of New Castle, Kent, and Sussex-on-Delaware, asking for 102 feet on the north side of said squares of the lot they proposed to buy, the part most convenient to place the present buildings on in order to have the opening to the south and to avoid the inclement northeast and northwest winds, and thanking him for his generous favor in granting the liberty to take stones from the bank of the Schuylkill to erect the buildings. The original of this latter request is on file at the Historical Society of Pennsylvania and the result of the above request for land is seen in the following note from the Minutes of the Managers of the Philadelphia Almshouse and House of Employment October 4, 1769:

"*Gentlemen:*—We have received your letter and Duplicate of the 6th of May returning to us your acknowledgements for our grant of the two lots, adjoyning the Land on which the House of Employment is built, and assure you the Accounts we received of your good management of so usefull a Charity, induced us with great readiness to make the Grant.

"We shall be always ready to show our regard for your undertaking, and are

Your very affectionate friends,
"THOMAS PENN
"RICHARD PENN

London, July 15, 1769."

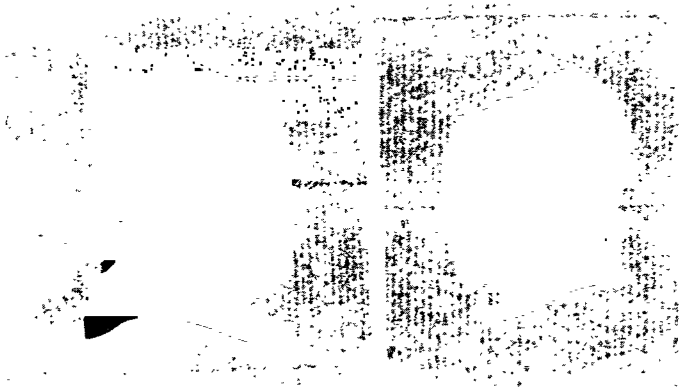
On July 25, 1770 we find a note that John Dickinson donated £200 on the occasion of his marriage. December 22, 1779 he donated £1000 and 200 cords of wood from his estate in Kent and *modestly* told them that he wanted to clear the land at any rate. Clement Biddle who was serving as an Overseer of the Poor at this time was on the committee to accept Dickinson's donation.

Showing Pine Street front. A detail from the original of John Reed's map, owned by the Library Company of Philadelphia. (Printed by permission of same.)

The earliest original record which we have at the Philadelphia General Hospital is a book called Bonds of Indemnity and Memorandum of Indentures of the Poor 1751. Benjamin Franklin's name appears as a magistrate and the names of many other members of the American Philosophical Society are listed in this book as Overseers of the Poor of Philadelphia from 1751 to 1796, among whom were John F. Mifflin, Clement Biddle, John Penn, Abel James, Philip Syng, Hugh Roberts, Joseph Fox and Samuel Rhoades.

Thomas Fisher, an Overseer, was delegated on April 11, 1774 to look after the French Neutrals, (Minutes of the Overseers) later to be immortalized in the poem "Evangeline."

The hospital played an important part in the Revolutionary War. It was immediately seen that this large institution was a suitable place for the sick soldiers. There is a note on November 19, 1776 that sick and wounded soldiers were cared for at the Bettering House, which was some time



Silhouette of Mr. and Mrs. Philip Syng, made April 7, 1772. From the Collection of the Historical Society of Pennsylvania. Mr. Syng was an original contributor to "The Relief and Employment of the Poor, etc." (The Philadelphia Almshouse) in 1766 and one of the original board of twelve managers. Also an Overseer of the Poor of Philadelphia. In 1769 it is noted that he was paid 3 shillings for "Plugging and regulating gold among monies received . . . too light."

before the Pennsylvania Hospital was used for the same purpose. The Managers of the Almshouse and House of Employment objected to the admission of the sick soldiers but were over-ridden by the Counsel of Safety. The Managers soon had more to contend with than their friends of different political opinion. On September 26, 1777 the British entered the city to remain until June 17, 1778 and before long General Howe seized the Almshouse for barracks, driving the poor out to the Free Masons Lodge, the Friends Meeting House, 4th and Arch Sts., and Carpenters Hall. These buildings were occupied by the Philadelphia Almshouse for some time. The Managers decided to see General Howe and enlist his aid. After several attempts they were unable to get beyond the General's aide-de-camp until they enlisted the help of Joseph Galloway, the well-known Tory, who immediately got them an interview with the General, to whom they presented their petition in person as follows:

Minutes of the Managers, November 29, 1777

The Memorial of the Managers of the Contributors to the Relief and Employment of the Poor in the City of Philadelphia—

To Sir William Howe, General & Commander in Chief of the King's Forces in America.

Respectfully showeth

That we have now not less than two hundred helpless and destitute poor under our care and superintendance who have heretofore been supported by an equal Taxation laid on the inhabitants of the City and Suburbs; but from the late total abolition of all Civil Government these miserable objects of our humanity and Compassion, notwithstanding our utmost exertions in borrowing and begging Money for their Relief are likely not only to Suffer all the miseries of extreme distress but must soon perish thro' the want of the Necessaries of life as we have not more provisions than will sustain them three days nor more Fuel than will keep them warm three weeks, nor are we by any means in our power capable of procuring them articles, there being no police established to which we can apply for that purpose. Under the distressing circumstances we are induced to apply to the General for such relief for these unhappy people as his wisdom and goodness shall think most proper and expedient.

(Signed (among others) BENJAMIN MORGAN

The result can best be seen by reading the Minutes.[1]

ACCOUNT OF THE RESULT OF THE VISIT TO GENERAL HOWE.

MINUTES OF THE MANAGERS OF THE PHILADELPHIA ALMSHOUSE AND HOUSE OF EMPLOYMENT, 12 MO., 3D DAY, 1777.

On 1st day, 30th, 11th mo. 1777, The Memorial as above delivered to one of the General's Aid de Camps who desired them to call next day at 10 o'clock for his answer, which they did, but were informed the General was too much engaged to give attention to it, and so from time to time for several days until the 4th day when the Treasurer got admittance and informs the General discovered a good disposition towards the Relief of the Poor, and referred him to the Commissary for such articles as they could best spare;

[1] This and other references are from the Minutes of the Managers of the Philadelphia Almshouse and House of Employment, The Minutes of the Overseers of the Poor of the City of Philadelphia and the Northern Liberties of the same, the District of Southwark and the Townships of Moyamensing and Passyunk and Roll Books in the Philadelphia Almshouse.

But on application to the Commissary was acquainted they had but a bare sufficiency for themselves, and consequently could spare none until a Fleet arrived which they daily expected. Great indeed was now our difficulty, our Bread and Meat expended and nothing left for the Poor but Vegatables, to add to this painfull Dilemma at 9 o'clock the succeeding night, the Barrack Master called on one or two of the Managers & informed them the House must be cleared the next day for the reception of the Kings Troops on which the Board of Managers & Treasurer was called at 8 o'clock next morning who unanimously agreed we could take no part in such a procedure, for this purpose we waited on the Barrack Master and acquainted him with our conclusion, laying before him the great hardships the Poor must be subjected to thereby notwithstanding this, an Order was sent to John Cummings to put their requisition in Execution by removing the Poor to the Free Masons Lodge, which was done to the very great damage and loss of the Public & great distress to those poor people. We apprehended we might now have withdrawn ourselves from any further care or attention to them, had not motives of tenderness and humanity for those Indigent, superior to every other consideration, influenced some of us to continue the arduous task, and it is with pleasure we here remark the Tenderness, Sensibility and attention given these poor people by our Steward. The Lodge being found every way inconvenient and too small to contain them, induced us to make an application to Friends for their Meeting House in 4th Street for their better accommodation which was obtained, and the Trustees of the Carpenter's Hall on application to them gave us liberty to the use of their House until a more convenient one can be provided, and the Poor are now placed in those Houses.

Not only did the Almshouse have a very active connection with the Army but we also find we have instances associating it with our budding Navy consisting chiefly of "Privateers of the Port." We note for instance that Isaac Jones was one of a committee to wait on the Agent for the Saratoga, a state ship, in behalf of Mrs. Sharpe, an inmate of the Almshouse and widow of Samuel Sharpe, to inquire after his prize money.

The earliest medical staff of the Philadelphia Almshouse was composed exclusively of members of the American Philosophical Society. They were in order of appointment: Dr. Wm. Shippen—about whom there is some question

[illegible] SHIPPEN [illegible]

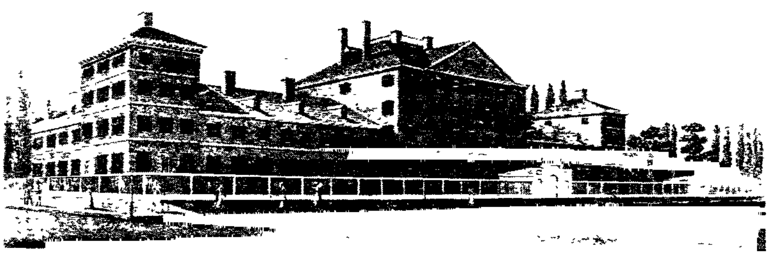
[illegible]

Member of the Continental Congress

A member of the Medical Staff of the Philadelphia Almshouse in 1768 and possibly in 1751. At the Library of the Historical Society of Pennsylvania we find the following note about this portrait: "The original of this is the sepia sketch in the possession of Dr. Buchanan doing duty as a portrait of Dr. William Shippen, Sr. From the sepia an etching was made by Albert Rosenthal in 1884 and labelled Dr. William Shippen, Sr.

(Signed) D. McN. Stauffer

4-26-1910."



The Philadelphia Almshouse and House of Employment with intended railing.
Wm. Strickland, Del't J. Boyd, Sculp't

From a print at the Free Library of Philadelphia, the gift of Miss Lydia T. Morris. Showing the Spruce Street front, period about 1815 (R. J. H.).

whether he served in 1751; Dr. Thomas Bond, 1770; Dr. Cadwalader Evans, 1770; Dr. Adam Kuhn, 1772; Dr. Benjamin Rush, 1772; Dr. Samuel Duffield, 1772; Dr. Gerardus Clarkson, 1772; Dr. Thomas Parke, 1773—elected to succeed Dr. Evans; Dr. Geo. Glentworth, 1779; and Dr. Jackson, 1779. Doctors mentioned in relation to patients but not members of the staff were: James Hutchinson, John Foulke and John Morgan. The following doctors appear as contributors: Samuel Preston Moore, Thomas Cadwalader, John Kearsley, Thomas Graeme, John Redman. Other contributors in 1778 were: George Bryan, John Dunlap, Michael Hillegas, Levi Hollingsworth and Hon. Robert Morris.[1]

The inmates of the institution as shown by the "Book of Daily Admissions" with comments by the Steward, were a varied lot. Not only were the sick poor admitted with notes of varied ailments, such as fitts, flux, ship fever, ague, scurvy, yellow jaunders, but many other diagnoses well-known in modern medicine, including traffic accidents. The drunken, venereal and disreputable part of the community also sought refuge in the Almshouse. There are many notes remon-

[1] See footnote, p. 315.

strating with the policy of the politicians in charge, saying that these people should be sent to "the gaol or the workhouse." The unruly ones were chained to a large log or whipped at the post as in the following instance: "Thomas Oakley, one of the most notorious scoundrels that we have ever been plaged with, for upwards of twenty years a public nuisance, was whipped at the post in this yard nearly about that time by order of ——— The Mayor of the City, a frequent inhabitant of the Gaol, the Workhouse and this place and now returned to us ragged, lousy and as diseased as ever." In addition to these, of course, the poor of the city were employed at weaving, picking oakum and other simple tasks in an effort to improve their condition. "The Bettering House" was the colloquial term given to the institution, possibly used seriously or it may have been in derision.

We believe that there was always a Hospital Department at the Philadelphia Almshouse. Our oldest records prove the treatment of the sick by a medical staff. The records of the original Almshouse are lost, so that we can only judge what took place there by comparison with records which are extant. Very few references to the First Almshouse have been found in contemporary literature but as is so invariably the case in other lines of activity, we find that Benjamin Franklin had something to say about it. In his account of his activities in establishing the Pennsylvania Hospital, he says that at the end of the year 1750 the Almshouse and the House of Correction were the only places at which lunatics of the city might be confined and that it was by no means fitted for such a purpose.[1] We believe that the first place where the sick were sent to be treated by doctors in Philadelphia was the Philadelphia Almshouse.

A great deal more might be said about the part that members of the American Philosophical Society played in the history of the Philadelphia Almshouse and Hospital but the subject is too long to be dealt with in a short address. On

[1] History of Pennsylvania Hospital 1751-1895—Morton.

looking into the question of whether men were mentioned in the Almshouse records before or after they were elected members of the American Philosophical Society we find an equal division. One-half were connected with the Almshouse before election to the American Philosophical Society and the other half afterward. We might conclude membership in the Philosophical Society was necessary before one could be appointed to the Almshouse Staff. Practically the entire staff were members of the American Philosophical Society before we have any record of them at the Almshouse. The only exceptions to this are Dr. William Shippen, who may have been connected with the Almshouse in 1751, who was elected a member of the American Philosophical Society in 1767 and who served at the Almshouse in 1768 and Thomas Parke, who was elected to the staff of the Almshouse in September 1773, and to the American Philosophical Society in January 1774.

Every man I have mentioned was a member of the American Philosophical Society except Thomas Penn; Sir William Howe; John Cummings, Steward; Samuel Sharpe, Sailor; and Thomas Oakley, the notorious scoundrel.

Note.—I wish to extend my thanks to Mr. John Ashurst of the Free Library of Philadelphia and Mr. Spoffard, Historical Society of Pennsylvania for their courtesy in selecting and providing illustrations and material.

EXCAVATIONS AT THE TEMPLE OF DEIR EL BAHRI, 1921–1931

By H. E. WINLOCK

(Read April 22, 1932)

In 1501 B.C., at the end of a short and uneventful reign, King Thut-mose II "went forth to heaven to mingle with the gods, and his son (Thut-mose III) stood in his place as Lord of the Two Lands, having become ruler on the throne of the one who begat him,"—to quote the contemporary biography of the courtier Ineny. The boy, however, was still a youth—perhaps no more than ten years old—and Ineny's biography goes on to recount how it was the widow of Thut-mose II, "the God's Wife Hat-shepsut who managed the affairs of the Two Lands according to her own devices."

There was no impropriety in the situation. The dowagers of the royal family of Egypt, in the XVIII Dynasty at least, had always occupied a position of great dignity and had served as regents on occasion. The youth of Thut-mose III at his father's death would have made a regency natural, and Hat-shepsut was not only the widow of the last king, she was by birth the head of the family. A complicated series of brother and sister marriages had made her the aunt and step-mother of the titular boy king, and his marriage in turn with Hat-shepsut's infant daughter, Nefru-Re, had made Hat-shepsut his mother-in-law as well. We may take it for granted that with so many claims the young widow's position as regent was unquestioned by the Theban court.

And now for the second personality whose name is intimately connected with the temple of Deir el Bahri. Sen-Mut, as shown in his tomb discovered by us, was a spare, striking-looking man with alert features and an aquiline nose (Fig. 1)—the steward and chief of the works in the temple of Amun at Karnak. His origin was obscure. In his autobiographical

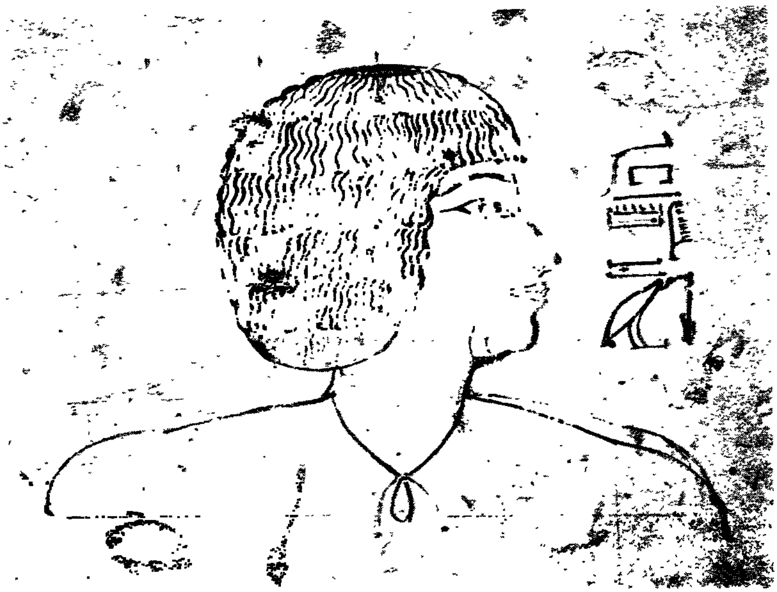


FIG. 1.—Portrait of Sen-Mut from his tomb.

inscriptions he frankly admits that his career really began only with the death of Thut-mose II, but once he had gained the attention of the young widow regent, he rapidly rose to be High Steward of the Royal Household, Guardian of the little Princess Nefru-Re, Chief of All the Royal Works, and holder of scores of other titles, some purely honorary but many of them positions from which an astute oriental grandee could readily draw a handsome income. But to me personally one of the most striking evidences of his prominence is a potsherd which we unearthed at Deir el Bahri a few years ago. On it an ancient scribe had jotted down an account with entries against the four great powers of the land, "the Pharaoh," "the Estate of the Queen," "the Treasurer," and "Sen-Mut," who alone of the four was well enough known to appear under his own name without the need of any title.

Sen-Mut was the foremost of a little group of Hatshepsut's special adherents to whom the one difficulty in the

situation was the approaching maturity of the boy Thutmose III and the ending of the regency—a difficulty they boldly met by declaring Hat-shepsut's assumption of a full and permanent co-regency. Since a woman could not be ruler over Egypt, Hat-shepsut assumed the titles of a king, and most of the state portraits from now on showed her crowned and bearded like the sovereigns of old. Thus Egypt had two kings, and in order that the people might not notice the innovation, documents were still recorded as of the reign which had begun with the death of Thut-mose II. Furthermore, Hat-shepsut gave it out that her assumption of the crown was but carrying out the wish of her father, Thutmose I, and the mandate of the god Amun.

The kings of Egypt in the Theban period were the offspring of Amun. Each "King's Great Wife" was "the God's Wife" and bore a divine child who should succeed to the throne. Hat-shepsut published to the world the story of her own immaculate conception—how Amun had notified the gods and had sent the god Tehuty to announce his coming to the Queen Ah-mose, and how the child Hat-shepsut had been conceived, born, acknowledged, and finally crowned by her divine father before all the gods. But the fiction did not stop with the miraculous. She actually caused to be written a purely imaginary account of her coronation by her mortal father in the presence of all his courtiers, and in order that this fiction should be perpetuated in imperishable stone, Sen-Mut was charged with the building of a shrine in which the divine right of Hat-shepsut should be the central theme. Deir el Bahri was the site chosen.

The nucleus of the plan (Fig. 2) was a sanctuary where the statue of Hat-shepsut's divine father, Amun, might rest when it was brought from Karnak each year at the "Feast of the Valley," and where Hat-shepsut might greet it with offerings. In the temple courts and porches were to be displayed the story of her divine birth, the festival processions which she organized for the god, the expedition she sent to Punt for spices and aromatic trees for the service and the

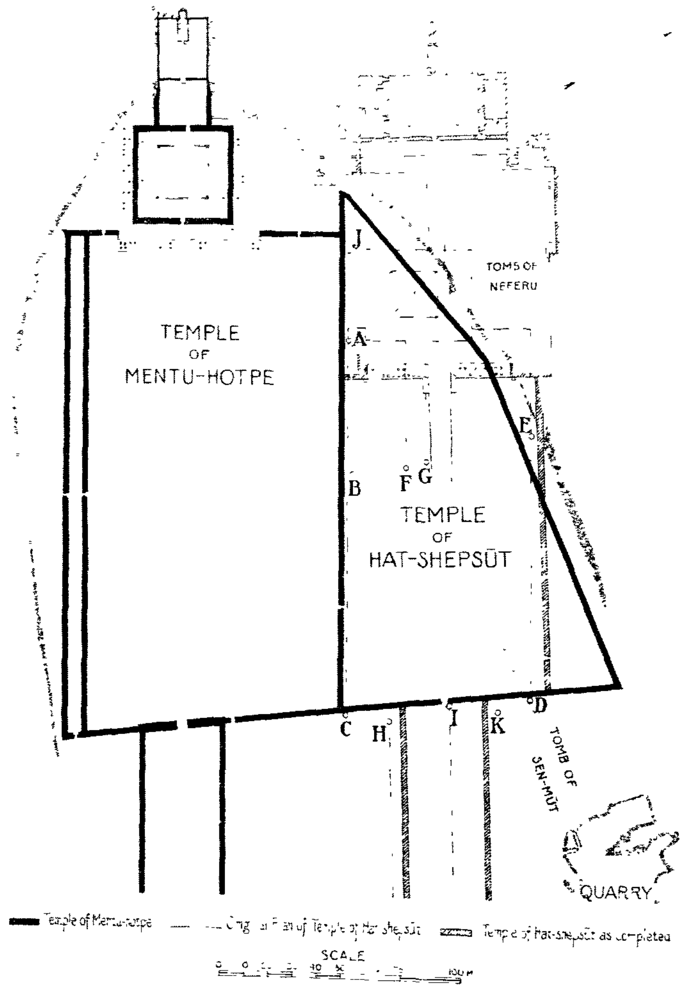


FIG. 2.—Plan of the temples of Mentu-hotpe and of Hat-shepsut.

gardens of Amun at Karnak, and the account of the transport and erection of the obelisks which she set up in his honor.

Hat-shepsut's claims rested equally upon her inheritance from her mortal father, Thut-mose I, who had long since been buried in a tomb which Ineny had prepared for him in the

Valley of the Kings. Part of the new temple was to be devoted to the services of Hat-shepsut's tomb which was being tunneled from the cliffs at the head of the Valley of the Kings, eastward through the hill toward a point deep under the temple site. Just as the mediaeval Venetians robbed Alexandria of the body of Saint Mark, believing that its possession in their cathedral would work to their advantage, so Hat-shepsut caused her father's body to be transferred into her own tomb and built a funerary chapel to him beside her own chapel in the new temple, in order that all the world, being impressed with her association with her father, might accept her succession.

So much for the origin of Deir el Bahri, as we have worked it out. A word or two now on what we have discovered as to its date.

In the second year after the death of her husband we know that Hat-shepsut was still only queen regent. In the ninth year returned the ships of her famous expedition to the spice lands of Punt which she had sent out as king. Sometime between these two dates she usurped the co-regency, and obviously the foundation of her temple was one of the first of her acts after the usurpation. Now a piece of a jar labeled the seventh year was found by us under the temple avenue, and since the avenue would have been one of the first parts of the temple prepared, the earliest date for its founding would be the seventh year. But the expedition to Punt, which must have gone out in the eighth year, also immediately followed the usurpation probably, and the date of the latter is thus narrowed down to between the seventh and the eighth years, with the probability in favor of the latter. There is reason to believe that the actual temple foundation ceremony took place in the autumn, the auspicious season for founding buildings, and furthermore the season of the ripening of the fruits which we discovered in the foundation deposits of this temple. Therefore, we suggest September or October of 1494 B.C. as the date of the founding of Deir el Bahri.

Hat-shepsut's daughter, Nefru-Re, was alive in the

eleventh year—1491–1490 B.C.—but she seems to have died soon afterwards. As her portrait appears among the living members of the royal family in the decorations of the sanctuary, we may assume that those decorations were completed about 1490 B.C., four years after the founding. Nefru-Re's portrait does not appear elsewhere in the temple, and as a matter of fact, we have excellent evidence that much of the rest of the temple was not decorated for four years more. The heavy ramps and scaffolds of brick used in the building were not removed until the sixteenth year, for we found an ostracon of that date under the discarded scaffold bricks in a nearby hollow, and in one of the porches the subject of the decorations was the transport of the obelisks in that same sixteenth year—1486–1485 B.C. Hence, the greater part of the carving and painting of the temple walls was done after 1485 B.C. When Hat-shepsut died—very likely in January of 1479 B.C.—the last porch of the temple was still undecorated.

Meantime, Thut-mose III had become a grown man, impatiently awaiting the disappearance of Hat-shepsut. There is evidence from our excavations that he first contrived the end of Sen-Mut. Possibly he had a hand in that of Hat-shepsut. In any case, immediately upon her death he gave orders that her name should be deleted from the official chronicles and that every portrait and every mention of her should be obliterated from the monuments. At Deir el Bahri the wreckers smashed up every single one of Hat-shepsut's statues and hurled them into the nearby quarries, and the stone cutters chiseled her name and her portrait from every wall and column, respecting only the figures and the symbols of the gods. Probably the entire temple would have been razed to the ground had it not been for its Amun sanctuary. But that saved it, for after all, a structure once dedicated to the god could not be lightly abandoned, and as an after-thought Thut-mose III ordered that where Hat-shepsut had once appeared, the portraits and names of his father, Thut-mose II, should be recarved over the obliterations. It was too late to alter the statues—they were hopelessly ruined

—but some effort was made to refurbish the temple, which was now reattributed to Thut-mose II.

The history of the temple during the succeeding centuries need not detain us. Owing to faulty foundations, parts of it collapsed with the passage of time. Falls of rock from the cliffs above buried some sections, and a monastery built of crude brick in the early Christian period hid a good deal of the rest. In the early nineteenth century a few half-hearted attempts were made to excavate it, but it was not until 1894 that the task was seriously undertaken by the Egypt Exploration Fund under Naville. He cleared the greater part of the structure, in the succeeding years most of the porches were temporarily reconstructed, and it is in this condition that we of the present generation have become familiar with Deir el Bahri. The great court and the surrounding hillsides were left by Naville in their original condition, fortunately for us, for some of the most important data on the temple lay buried there.

Our interest in the temple began in the season of 1921–22. We were looking for the northern limits of the great court in front of the temple which Mentu-hotpe had built about 2000 B.C. to the south of the site on which Hat-shepsut built her temple 500 years later. To our great surprise our search led us right across Hat-shepsut's court, and it was only on the far side of the latter that we discovered Mentu-hotpe's northernmost wall cutting diagonally under Hat-shepsut's structure. Sen-Mut had chosen the area already graded by the earlier king as the site for his queen's temple.

It was at about this time that we began to find the deposits laid on "the day of the stretching of the cord," as the ceremony of the founding of a temple was called. Pits had been dug at each important point in the projected structure, and in each of these pits were deposited specimens of the tools and materials with which the temple was to be built, and samples of the food and drink to be offered perpetually in the sanctuary to the god. By the time our excavations were finished we could account for eleven of the series of deposits.

At first view they seemed to have nothing to do with the temple as eventually built. At second glance a curious fact became evident. *A–B–C–D–E* are the limits of a court. *F–G* are obviously the foot of a ramp, off center in the court like the ramp of the Mentu-hotpe temple. *H–I* could well be the beginning of an avenue in line with the ramp and leading to the cultivation—again just as in the Mentu-hotpe temple. *A–J* could easily mark a platform for the temple proper. *K* seems to belong to a later period in the plan. In other words, we could trace—as we have done here with a dot and dash line—a temple plan identical with that of Mentu-hotpe.

A curious fact, however, is that this first plan of Sen-Mut's is smaller than Mentu-hotpe's. The ratio is consistently as five is to seven—a ratio which struck me as inexplicable until I recalled the fact that the Egyptian unit of measure, the cubit, was divided into seven palms and that a reduction from seven to five was a very practical one for Sen-Mut. Hat-shepsut and Sen-Mut obviously doubted their ability to equal the more ancient king's monument when they began to build. Before they had finished, however, their ambitions had risen until they ended by erecting a structure far larger than their original model.

At the side of the Mentu-hotpe court was the rock-cut tomb of Queen Nefru of the XI Dynasty. As the plan of Hat-shepsut's temple developed, one of the porches blocked off the tomb entrance and the grading of the middle court buried it completely. It was only because of the collapse of the porch that the tomb entrance was visible in modern times. And yet the tomb had frequently been visited throughout the XVIII Dynasty by tourists who had scribbled their names upon the walls. Nefru's tomb was already 500 years old in Hat-shepsut's day and was regarded as a site worthy of a visit, just like another XI Dynasty tomb on the hillside above in which we found the record of a visit by the High Priest of Amun, Neb-neteru, in the 17th year of Ramesses II. The problem was, how had the ancient tourists entered Nefru's

tomb and how could we provide an entrance for the modern tourists once the porch was reërected.

The solution was unexpected. Stone walls were found beside the tomb entrance, obviously contemporary with the temple. When we cleared them, we found that we had a sloping tunnel, partly built and partly cut through the rock, leading up to the middle court of Hat-shepsut's temple where Sen-Mut had provided an entrance for the tourists of the XVIII Dynasty.

The completed temple differed essentially from its model, beside which it stood. Sen-Mut retained only the idea of the colonnaded terraces. He omitted the pyramid which was the central motif of Mentu-hotpe's plan and developed a structure of broad open courts, unique in Egyptian architecture.

I shall have no time to go into all the details of the temple architecture which we discovered. We were able to change radically the previous conception of many of them, but probably our most fundamental changes have to do with the discovery of the temple statues of which no trace was known hitherto.

As we have already noted, the wreckers sent into the temple by Thut-mose III not only obliterated every representation of the queen on the walls but they removed every statue. They hauled them down the avenue and tumbled them into the hollows and quarries on either side. We first found traces of them in 1923, and for the next six years we were unearthing scattered fragments on every hand, until in the end we had recovered parts of at least eighty statues and sphinxes.

We had long noticed traces of Osiride statues built in at each end of the topmost porch, and in the quarry we found fragments of twenty-four more Osiride statues, once eighteen feet high, which had stood with their backs against the columns which stretched across the entire top of the temple. None were complete, but we found one colossal head which in spite of its rough treatment was nearly perfect. We had also noticed that at either end of the lower porch something

had been cut away by Thut-mose III. When we began to unearth the fragments of limestone statues we found that we had the greater part of two more Osiride statues, each twenty-six feet high, which fitted perfectly into those two places, and one of these we rebuilt on the spot. Here was something entirely new in our ideas of the temple. Hat-shepsut had caused herself to be shown as Osiris, the god of the dead, standing swathed in bandages gazing across the desert to the Nile.

A more difficult problem came with another lot of Osiride statues, eleven feet in height. In the topmost court of the temple there are ten niches in which such statues must have stood, but we discovered that we had fragments of fourteen heads. We could not think where to place the extra four until one day just a year ago, happening to be in the sanctuary when the rays of the early morning sun were coming in the door, I noticed for the first time in that bright light that four such statues had been cut out of the four corners of the room. With this lead to follow, I soon found that four of our statues were easily segregated from the others by their color and their workmanship. Immediately, an interesting fact resulted, well illustrated by Fig. 3. You will recall that the sanctuary was finished six years or more before the rest of the temple. During that six years a new school of sculptors had arisen, and the conventional portrait of Hat-shepsut had completely changed, from the earlier sanctuary portrait shown here on the right to the later type from the niches, shown on the left.

All the limestone statues had suffered from their removal and from their subsequent exposure to a much greater extent than the statues of granite, and it was on the latter that our efforts at restoration were most successful.

The little granite kneeling statues (Fig. 4), of which we found eight almost complete, had merely been broken by the ancient wreckers into two or three pieces to lighten them, and the fragments had been hurled into the hollows outside of the temple without more ado. The larger statues had been hauled on sledges down to the quarry and there broken up.

FIG. 3.—The head of an Osiride statue from the sanctuary (right) and one from the niches (left), now in the Metropolitan Museum.

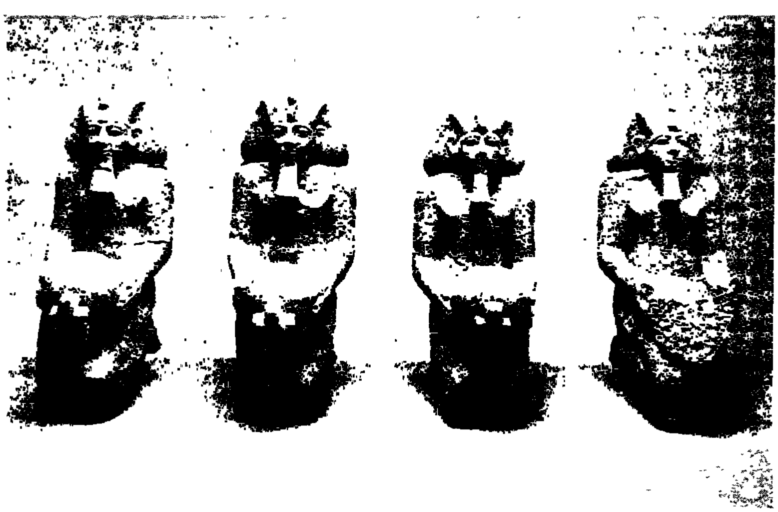


FIG. 4.—Small kneeling statues of Hat-shepsut in granite.

In the course of our successive campaigns we had collected an enormous number of fragments which had to be laboriously sorted out. As time went on we were able to recognize minute differences in the texture of the various qualities of red granite, and we became familiar with the anatomy of sphinxes. Some of the scraps were no bigger than the tip of one's finger; others were so ponderous that they could only

FIG. 5.—Granite sphinx now restored in the Berlin Museum.

be handled with a derrick. But gradually there grew up on our work a row of statues and sphinxes, becoming more and more complete as our sorting went on. Every one of them had to be temporarily assembled on the spot in order that an intelligent division between the Egyptian Government and the Metropolitan Museum could be made, and then they had to be dismantled once more for shipment.

Under the derrick a great granite sphinx began to take

form, its body almost complete but with no trace of a head. I happened to recall the head of such a sphinx which Lepsius had taken to Berlin in 1845. On the way out to Egypt in 1928 I went to see it, and the moment I saw the texture of the stone and the shape of the breaks I was convinced that it fitted on the body at Deir el Bahri. A photograph of the head and a photograph of the body, taken from the same point of view and in similar lighting, could be joined together in a most convincing way (Fig. 5).

FIG. 6.—Marble statue now restored in the Metropolitan Museum.

There was also in Berlin a headless statue of Hat-shepsut in creamy white marble. We had dug up a head of the same material and chips which obviously would fit on the mutilated body. It was easy to demonstrate that our head and the Berlin body belonged together (Fig. 6).

Fig. 7.—Colossal granite statue now restored in the Metropolitan Museum.

To the Director of the Egyptian Section of the Berlin Museum, Dr. Heinrich Schäfer, and to me there was only one possible course. We felt that the scattered fragments of these statues must be brought together again, and when all formalities had been arranged with the Prussian Government on the one hand and the Trustees of the Metropolitan Museum on the other, we made an exchange. Berlin received the body of the sphinx, and with its head which they already had, it has been restored in the Berlin Museum. We received the body of the marble statue, and with the head which we had discovered, that masterpiece of Egyptian sculpture now stands complete in the Metropolitan Museum.

There was still a third piece of sculpture which Lepsius had brought to Berlin in 1845—a colossal granite head wearing the crown of Upper Egypt. I recalled a nose, a chin, and fragments of the Upper Egyptian crown out at our work at Deir el Bahri which I was sure would complete the Berlin head. And furthermore, we had the greater part of the body. This head also came to New York in exchange for one of the small complete kneeling statues in Fig. 4, and the statue is now completely restored in the Metropolitan Museum (Fig. 7).

I did not have such good fortune in another case. I had read in one of the older publications of a torso of Hat-shepsut brought from Egypt by Prince Henry of the Netherlands at the time of the opening of the Suez Canal in 1869. I made inquiries in Holland. The torso was eventually located in one of the royal palaces, and the interest of the authorities of the Leyden Museum having been aroused, they procured it as a gift from the Queen Mother—an unfortunate result of my inquiries, for the Leyden Museum does not feel that it can dispose of a royal gift even by exchange. Nevertheless, my investigation was worth while, for a cast of the Leyden torso taken to Egypt fitted perfectly to the lower part and to the head which we had found of one of the very rare statues of Hat-shepsut as a woman (Fig. 8).

In another case we found the material for restoration in a

most unexpected way. We had accumulated a number of fragments of a statue of the infant Hat-shepsut on the lap of her nurse, whose name was missing. Curiously enough, we found that there is an ostracon in Vienna on which an ancient scribe had written a first draft of an inscription, and I feel perfectly convinced that it was for this very statue.

FIG. 8.—Granite statue, of which the head and lower part are in the Metropolitan Museum and the torso (in this photograph a cast) is in the Leyden Museum.

From the ostracon we could fill the lacunae and determine the name of the nurse, "Sit-Re, called Yen."

We are in a position now to appreciate what a large part statuary played in Sen-Mut's plans for the queen's temple.

The procession bearing the barque of Amun ascended the avenue between two rows of gigantic sphinxes of sandstone brilliantly painted. Passing through the gateway it crossed the great court, with more sandstone sphinxes on either hand, and started up the first stairway, at the top of which a little sphinx sat on either balustrade (Fig. 9). To the archæologist

Fig. 9.—Small limestone sphinx from the balustrade of the first stairway, now in the Cairo Museum.

these two little sphinxes have an especial interest as being of that very rare type known heretofore only in the famous sphinxes from Tanis of which not only the body but even the head is a lion's and only the face is human.

The procession was now on the middle platform of the temple, passing through another aisle of sphinxes, here made of granite. The sphinx in Berlin was one of these, and two others we sent to the Cairo Museum. A fourth is shortly to be erected in the Metropolitan Museum. The barque was

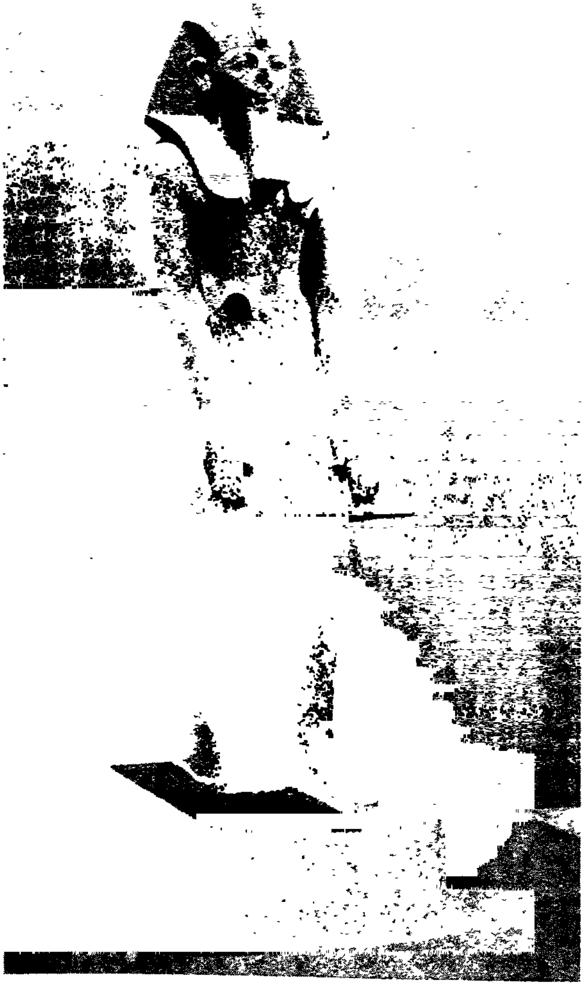


FIG. 10.—Large granite statue from the upper vestibule, now in the Metropolitan Museum.

now borne up the second stairway, and passed under the colonnade of Osiride statues and into a vestibule flanked on either hand by standing statues of Hat-shepsut in red granite (Fig. 10). Only one more court preceded the sanctuary itself

FIG. 11.—Colossal granite statue from the upper court, now in the Metropolitan Museum.

FIG. 12.—Bas-relief of Sen-Mut kneeling, in one of the cupboards of the temple.

where the barque was to rest. Since the decorations of the sanctuary show Hat-shepsut kneeling before the barque and offering jars of wine, in the court in front must have knelt eight great statues of Hat-shepsut in the same pose. One of these has been reërected in Cairo. A second (Fig. 11) and the other with the head from Berlin have just been set up in

the Metropolitan Museum. Of the remaining five we only found fragments, but those fragments were sufficient to show us just how these statues had been placed. Two wore the crown of the North and undoubtedly knelt on the north of the court. Two others wore the crown of the South and must have been placed opposite them. Four others wore the *nemes* (Fig. 11). Those with the crowns of the North and of the South show us that the inscriptions on all eight read from the direction of the sanctuary door outwards, and we can divide the other four statues between the two rows according as their inscriptions read from the right or the left.

Of Sen-Mut, the architect, I should make a brief concluding mention. In the first days of his prosperity he began to build himself a magnificent tomb on a nearby hilltop. Later he dug for himself another tomb, at the temple, which we found in 1927. A commoner could not be buried within the temple precincts. Sen-Mut contrived to have the entrance to his tomb in the quarry outside, but by driving a subterranean gallery one hundred yards long, he arranged for his actual burial place to be under the temple court.

Not content with this surreptitious entry into the temple, he placed his portrait behind every door in the structure. One day some years ago I happened to be looking at a door-jamb in the temple when the light was at just the right angle to show where a picture of a praying man had been chopped away, and looking closely I could see Sen-Mut's name. Struck with this unusual appearance of a commoner in a sanctuary, I began to look around at all the temple doors and found that his portrait had been behind every one of them. Eventually we found in one case an inscription which stated that he had put his portraits here with Hat-shepsut's permission, and in a few dark little cupboards opening off one of the sanctuaries we found his figures unscathed by the wrecking gangs of Thut-mose III (Fig. 12). Sen-Mut, the architect, had signed his work, and here his signature had escaped destruction.

NOTE.—The illustrations are from plans and photographs made by the Egyptian Expedition of the Metropolitan Museum of Art. For the annual reports of the Expedition covering the excavations here described see the *Bulletins of the Metropolitan Museum* from December, 1923 to March, 1932.

SPECTROSCOPIC DISCOVERIES AT THE RECENT TOTAL ECLIPSE

By S. A. MITCHELL

(Read April 23, 1932)

THE specially interesting features of the coronal spectra at the 1930 eclipse on "Tin-Can" Island are the large dispersion and the absence of slit. All of the lines of the corona therefore show as complete rings and they exhibit interesting detailed structure, particularly in the strong 5303 and 6374 rings. In fact, this eclipse was the first time that so much of structure was shown in the coronal spectra. This was made possible by the fine definition obtained in the slitless images of high dispersion, but the chief cause was found in the great activity of the sun. The details in the coronal rings were compared with the chromospheric structure, especially in the strong lines of hydrogen-alpha and the K line of enhanced calcium. Comparisons were also made with the exquisite photographs obtained by the 63-foot tower telescope of the Swarthmore party by Professor R. W. Marriott. In addition, the eclipse spectra were compared with spectroheliograms taken at Mt. Wilson Observatory and at Kodaikanal in India both before and after the eclipse.

A comparison of all of the eclipse plates, both direct and spectroscopic with the spectroheliograms taken at the two great observatories far distant from Niuafoou Island, show that the sun was very active not only at eclipse time but throughout the period of four days covered by the photographs. The center of the longest streamer of the whole corona was situated 30° to the east of the south point of the sun. Intertwining the coronal streamers is a beautiful series of coronal domes. At totality, at the base of the long streamers and domes is an extended group of prominences. These prominences, though apparently very active, did not

reach the greatest heights shown on the eclipse photographs which were in fact at the seat of a conspicuous feature of the corona called the "strawberry dome."

For many long years all eclipse observers have called attention to the connection between coronal streamers and prominences. This dependence is abundantly verified at the 1930 eclipse, but this latest eclipse demonstrates the fact that the *longest* coronal streamers, on which the shape of the corona more or less depends, are not necessarily connected with the prominences which at the time of the eclipse are at *greatest height.*

The structural details of the coronal rings show that the maximum intensity in the corona is found always *near* the greatest strength in the prominences but does not *coincide with* the detailed structure of the prominences. It was a great surprise to find that the details in the coronal rings at 5303 and 6374 did not resemble each other, nor did either resemble the structure seen in the high-level lines in the chromosphere as K and H-alpha nor yet resemble the details in the direct photographs. These differences in structure show that 5303 and 6374 cannot take their origin in the same atom, or at least in the same atom in a given condition of excitation.

The Shape of the Corona

For half a century, the shape of the corona has been thought to be connected with the activity of the sun as revealed by the sun-spot cycle. For the past forty years the dates of maxima and minima of spots have been as follows:

Maximum	Minimum
1893.6	1901.7
1905.6	1913.6
1917.6	1923.6
1928.5	

The recent maximum has been a curious one, with great activity but with the Greenwich mean areas of both spots and prominences showing peaks in 1926 and 1928 while the annual means of Zürich numbers steadily increased from the date of minimum in 1923.

In *Handbuch der Astrophysik*, *4*, 317, 1929, there is stated the general problem of the dependence of coronal shape on solar activity. The eclipses of the past decade have been beautifully situated with respect to the sun-spot cycle and have added valuable information. The eclipse of 1922 took place shortly before minimum of spots, that of 1923 almost exactly at minimum. A year and a half after minimum came the 1925 eclipse, while those of 1926 and 1927 were just before and 1929 and 1930 just after maximum.

The information on the activity of the sun as recorded in the sun-spot cycle comes, as the name signifies, from observations on spots, their Zürich relative numbers, the Greenwich mean areas, the latitude of spots, etc. Similarly observations made on prominences, give also the numbers, mean areas, mean latitude, etc. The sun-spot and prominence curves closely parallel each other. In a sense, the information from prominences supplements that from spots in that the spots are phenomena observed on the face of the sun while the prominences are photographed only at the sun's limb.

To observe spots a moderate equipment, a mere telescope, is all that is necessary. The activity of the sun manifesting itself in spots can be observed as the spot moves across the face of the sun, measurements of polarity, etc., continued from day to day give a fairly faithful badge of the relative activity of the sun. In comparison, the prominences are transitory phenomena. Even if individual prominences were more permanent than they are, the rotation of the sun would carry them quickly out of sight. Occasionally when a total eclipse comes, the direct photographs of prominences and the eclipse spectra can be compared with spectroheliograph photographs. Then we see the limitations of the latter method. The eclipse photographs on October 21, 1930, showed the sun with a very stormy region in the southeast quadrant while the Mt. Wilson spectroheliogram taken only a few hours earlier showed nothing particularly remarkable about the activity in this quadrant. Unless the prominence exhibits both height and contrast through masses of gases in eruption, it is usually

not a conspicuous object on the prominence plates. Hence taken all things together, it has been generally felt by the average astronomer that the information from spots gives a more reliable indication of the activity of the sun than is obtainable from observations of prominences. As already stated, however, the two types of observations supplement each other.

When attempts are made to find correlations between coronal disturbances and either spots or prominences, it is evident on the face of things that many more connections must always be found between prominences and coronal structure than between spots and corona. The spots are seen on the *face* of the sun while both the corona and prominences stretch out from the *edge* of the sun. It must not be thought that of necessity there must be a more intimate connection between prominences and coronal activity than there is between sun-spots and coronal disturbances. The eclipse photographs show prominences and disturbed regions in the corona but from the nature of things cannot show spots. Unless the eclipse astronomer observes the spots on the final days before the eclipse—and he is usually too busy with a thousand and one duties that must be performed—or unless he looks up the literature afterwards (and this rarely is done) the possible connections between individual spots and coronal disturbances pass unnoticed.

Ludendorff [1] has done a valuable piece of work for eclipse investigators in providing a simple method of measuring the shape of the corona. This was done by utilizing both photographs and half-tone reproductions to draw roughly by eye lines of equal intensity surrounding the corona. From direct measures easily carried out, and by the method of least squares, two quantities a and b were determined, a giving the ellipticity of the corona at the sun's surface and $a + b$ the ellipticity of the corona at a distance of one radius from the sun's edge. It was then found that the value of a is nearly constant for all eclipses, the average size being 0.05,

[1] *Sitzungsber. der Preuss. Akad. d. Wiss.*, p. 185, 1928.

while on the other hand the quantity *b* varies in amount for different eclipses. When *b* is nearly zero, then the corona is nearly circular in outline which represents the "sun-spot maximum" type of corona. When *b* has its maximum value, the eclipse is most elliptical in shape and the corona is of the typical "sun-spot minimum" shape.

The appended table gives Ludendorff's measures but arranged according to the sun-spot numbers. In addition measures are included of the eclipses of 1922, 1929 and 1930. The German photographs of the 1929 eclipse were measured by von Klüber. The Lick photographs of the 1922 eclipse and those of Swarthmore of 1930 were measured by Miss E. T. R. Williams.

Spots Decreasing				Spots Increasing			
Eclipse	Spot Numbers	*a*	*b*	Eclipse	Spot Numbers	*a*	*b*
				1893.3 .	88	0.03	0.03 *
				1926.0 .	77	0.06	0.01
1918.4 ...	69	0.13	0.10	1927.5. .	67	0.04	0.00
1929.3 ..	59	0.10	0.02	1905.7. .	59	0.01	0.00
1908.0 ...	45	0.06	0.02				
1930.8 ..	35	0.04	0.23				
1898.1 ...	27	0.06	0.12				
1896.6 ...	22	0.03	0.23				
1901.4 ..	11	0.04	0.26	1923.7 .	11	0.06	0.18
1900.4 ..	9	0.03	0.29	1914.6 ..	9	0.05	0.16
				1925.1 .	8	0.05	0.10
1922.7 .	6	0.04	0.24				

* All values of *a* and *b* are positive except *b* of the 1893 eclipse.

The values of the quantity *b* are especially interesting. The three eclipses of 1900, 1901 and 1922, all of which exhibited the minimum type of corona, the average value of *b* being 0.26, took place on the average 0.9 years *before* the time of minimum of spots. The three eclipses of 1914, 1923 and 1925 occurred the same interval of time *after* minimum of spots, and yet the value of *b* had an average of only 0.15.

The three eclipses of 1896, 1898 and 1930 came about four years before the time of minimum of spots, and in spite of this the average value of b amounting to 0.19 was greater than that at a time less than a year after spot minimum.

The last sun-spot maximum took place in the middle of the year 1928. Although it is difficult to know with certainty how the sun is going to behave, yet it now looks probable that spots will not be at minimum until the year 1934. The eclipses of 1926 and 1927 showed the maximum type of corona. Some progressive modification of shape was seen in the 1929 corona, but yet it had essentially the maximum type. It would not have been much of a surprise if it had been found that a year later the progression had given a corona of "medium" type. It was very startling to find that four years before the expected time of minimum of spots the corona showed in 1930 the essential characteristics of the minimum type of corona.

The author was partially prepared for the surprise of the 1930 eclipse for he had announced in 1929 as the result of a study of direct photographs and spectra that the corona two years in advance of both the maximum and minimum of spots always takes on the characteristic shapes.

In spite of the uncertainty connected with the time of minimum of spots, the writer is going to be rash enough to predict that at the coming eclipse of August 31, 1932, the corona will show the typical corona called the minimum type, of long equatorial extensions and strong brushes surrounding the sun's poles.

PRELIMINARY REMARKS ON THE ANTHROPOLOGY OF THE AMERICAN CRIMINAL

By EARNEST A. HOOTON

(Read April 22, 1932)

An inveterate and vicious habit of the human mind is that of pre-judging. Prejudice is a decision based on emotional bias rather than on an impartial consideration of evidence. Such a judgment of ignorance is the greatest deterrent to progress. I doubt not that the ancestors of present great apes cherished a fatal prejudice against ground-dwelling and the erect posture.

The most disgraceful product of civilization is the criminal and the most abject failure of social science is the criminologist. I make this latter admission without shame, since I am not a criminologist but an anthropologist. Confession of the sins of others is especially good for the soul. It seems to me that the student of the criminal has been infected too often with a fatuous philanthropy which creates the prejudice that the evil-doer is but an unfortunate warped by environmental circumstances, such as foreign-born parents, broken homes, slum neighborhoods, and the financial opportunities afforded by prohibition. I do not wish to belittle the efforts of these idealists to eliminate crime by preventive environmental measures, but it is depressingly apparent that crime in this country is increasing, in spite of juvenile courts, social centers, and a host of charitable, educational, and reformative agencies. There seems to be an ineradicable prejudice in the minds of most Americans, whether they be physicians, jurists, sociologists, psychologists, or merely statesmen, against any examination of the hereditary factors which may be productive of criminality. This is doubtless an expression of our democratic dogma "that all men are created free and equal,"

so noble in its political intention and so ridiculously untrue in any biological or sociological connotation.

It is largely because of this prejudice that the physical hereditary characteristics of criminals, defectives, and insane have been neglected. Criminologists consider it edifying to believe that a man can be saved by grace, but refuse to admit that he can be damned by germ plasm. Again, the very notion of human heredity has suffered equally from the denunciations of those who know not their ancestors and consequently feel inferior, and from the acclamations of those who imagine that they do know them and are thereby unduly elated. Human genetics has been confused with the pernicious snobbery of reactionary female organizations, with the despicable propaganda of racial bigots, and with the tombstone-scanning pursuits of genealogists.

It is not strange, therefore, that the anthropologist who dares to propose an investigation of the physical characteristics of the criminal, and of the relation of race and nationality to crime, should be greeted by that species of plaudit which the intelligentsia of our great metropolis describe as a "Bronx cheer."

I do not suppose that any scientifically trained person believes that the color of a man's eyes, the shape of his head, the form of his nose, and the protrusion or recession of his chin, determine his vocation in life—whether, for example, he is to be a bootlegger or a bishop. There can hardly be any causal relationship between the behavior of the individual and the normal variations of his physical features. But no one can deny that the mentality and temperament of a man intimately affect and in many cases predetermine his conduct and his whole mode of life. The mental stuff of man is principally the result of his individual, racial, and specific inheritance, although, doubtless, modified, and enriched or impoverished by his environment and his experience. Similarly, the physical characteristics of every human being are primarily and immediately due to his heredity, although displaying a limited plasticity under the molding hand of

environment. It then seems probable that the physical and mental features of the individual, both of which he owes to his heredity, may be associated, each with the other, in some sort of non-causative, but nevertheless relatively constant and significant linkage. In other words, a man's physical features may afford clues to his mentality and disposition. Such a relationship has never been scientifically demonstrated, possibly because of the extreme difficulty of measuring the intangible qualities of the mind. Then, if physical traits are symptomatic of psychological characteristics and if behavior is an expression of the mind and of the emotions, it is evident that there may exist an indirect relationship between conduct and physical characteristics *via* the mind. This hypothetical and far-fetched connection is worthy of investigation only, perhaps, because physical features are concrete and measurable, and behavior is obvious, not to say obtrusive, whereas mental characteristics are elusive and immeasurable.

Human races exhibit a community of physical features which they owe to their identical descent. An analogous racial similarity of mind and temperament is not inconceivable, although unproven. If racially identical individuals show the same anti-social proclivities, as indicated by the kinds of crime which they commit, it is evident that this correlation of behavior with physique must be due to their similar racial mental inheritance.

Of what practical use would be a demonstration that an individual or racial physical type is predisposed to a certain form of crime? It might help in the apprehension and identification of criminals—and it seems clear that the police need all of the help they can get. It might contribute to crime prevention through the examination of persons suspected of anti-social proclivities on the basis of bodily features. It might afford a better basis for the selection of immigrants. It might be of no practical value whatsoever, and hence be relegated to the ranks of crime commissions and surveys, which emerge periodically from behind closed doors, flap their wings, cry "cuckoo" a variable number of times, and retreat into innocuous obscurity.

For the past five years I have been investigating the physical characters of American criminals in their relation to type of crime, to occupation, education, and, where data were available, to mental and psychological classification. The subjects of this study include some 16,000 inmates of the penal institutions and insane asylums of Massachusetts, Wisconsin, Missouri, Colorado, Arizona, New Mexico, Texas, Kentucky, Tennessee, and North Carolina. Access to these institutions was made possible by the coöperation of the Massachusetts State Department of Mental Diseases and by the generous assistance of correctional officers and boards in all these states. In addition to the institutional inmates, a sample of some 2000 individuals of the non-criminal population was studied, in order to provide adequate norms with which to compare the characteristics of the delinquents and the insane.

After two years of field investigation, carried on entirely by assistants, and almost three years of laborious statistical analysis, accomplished by diligent young women and ingenious machines, I am in a position to state some preliminary findings, although scarcely to interpret them, even tentatively. The investigation centered about three queries, namely: Do criminals of the same racial origin differ in their bodily characteristics according to the type of crime which they commit? Do criminals of any given racial or national group differ physically from the law-abiding population of identical ethnic origin? Do the various hereditary physical groups which we call races differ in their criminal propensities? The answer to each one of these questions is "Yes." In this brief paper I must be dogmatic, but I am prepared to substantiate my contentions by a mass of statistical data consisting of some 120 morphological, metrical, and sociological observations on each of 18,000 subjects.

Here we can consider summarily a very few of the results obtained from the study of the twenty racial and ethnic groups investigated. We may begin with 4200 native American criminals of native parentage. Do these American criminals, classified according to the nature of their crimes,

differ physically from the totality of native born criminals of native parentage? One illustration must suffice. First degree murderers diverge significantly from total criminal population in that they are older, heavier, taller, bigger-chested, with greater head circumferences, narrower foreheads, longer and relatively narrower noses, broader jaws, broader ears, relatively narrower shoulders, relatively shorter trunks, relatively longer heads, less head hair, more body hair, straighter hair, more pronounced forehead slope, more convex noses, fewer and poorer teeth, both flatter and more projecting ears, less facial asymmetry, etc. Some of these differences, but by no means all of them, are due to the higher average age of this class of prisoner.

Seven of the ten offence groups of these criminals are clearly distinguished from the total series of native born criminals in their combinations of bodily measurements and indices and in observed morphological characters. Robbers, burglars and thieves, forgers, rapists, and even bootleggers, deviate in the totality of their physical features from random samples of their fellow-criminals of the same racial origin chosen irrespective of offense. This does not mean, however, that any crime is committed exclusively by individuals of one physical type. It implies merely that within this group, certain variations of physical features tend to be associated disproportionately with specific types of crime.

When the whole series of native born criminals of native parentage is compared with a sample of the non-criminal population of similar origin, it is apparent that in the sum total of their metrical and proportional features the criminals are also distinct from civilians. The differences consist principally of a marked inferiority in bodily dimensions on the part of the criminals, but also include some striking deviations in proportions. In the separate crime categories of offenders the physical differences from the general population are even more pronounced.

On the basis of racial physical characters, the Negro prison material was divided into an approximately full-blooded

Negro group of 766 subjects and a Negroid, or mixed Negro-White group, of some 3300 individuals. A little more than one-fifth of all Negro and Negroid prisoners show no perceptible traces of White admixture.

I do not yet know whether the full-blood Negro group is differentiated in physical type, according to the nature of crime. This group as a whole differs from our civilian check sample of pure Negroes, but the latter is so small that I hesitate to emphasize the differences. The prison Negro does not exhibit the inferiority of size when compared with his civilian brother, which is so striking in case of native White criminals. The mixed or Negroid criminals differ among themselves in physical type according to their offenses, but not as markedly as do native Whites. They are quite distinct from civilian Negroids, but resemble civilian non-college Negroids more closely than they resemble those who have undergone "higher education." The civilian college Negroids are much bigger than the criminals.

Time forbids even mention of the results of sorting all White criminals into racial types, according to physical criteria, and the remarkable offense differences of these racial types; of the curious and well nigh incredible relationship of body build to nature of offense in White criminals; of the differences between native born White criminals of foreign parentage and foreign born criminals of the same ethnic origin; of the differences between the criminal insane and the civil insane.

There was once a great Italian named Caesar Lombroso, who thought it worth while to study the physical characteristics of criminals. He conceived the idea that criminals could be divided into physical types according to the crimes which they commit. He used more of intuition than of logic; his scientific technique was appalling from a modern viewpoint; he utterly failed to prove his case. His theories have been abandoned by modern criminologists; but they still remember him, and scarcely one of them neglects to drop a brick upon his grave. I am no Mark Antony, and I come

neither to bury Caesar Lombroso nor to praise him. I have no mantle of that Caesar—either to don, or wherewith to incite to bloody revolt the members of the American Philosophical Society. The rent the envious Goring made may pass unnoticed and undarned, for aught I care. But after some years' study of perhaps the largest series and the most detailed data ever gathered for criminal anthropological purposes, I am beginning to suspect that Lombroso, like Darwin, was right.

EXCAVATIONS IN THE LATE NEOLITHIC FORTRESS OF HOMOLKA IN BOHEMIA

Work of the Second and Third Archæological Expeditions to Central Europe sponsored jointly by Peabody Museum of Harvard University, Cambridge, Mass., and the University Museum of Philadelphia, Pa.
Seasons 1930 and 1931

A PRELIMINARY REPORT

By VLADIMIR J. FEWKES

(*Read April 22, 1932*)

Acknowledgments

In the late summer of 1929 a small archæological expedition was despatched to Czechoslovakia by the Peabody Museum of Harvard University, Cambridge, Mass., and the University Museum of Philadelphia, Pa. Its purpose was to run preliminary soundings in a few sites and in general to investigate the possibilities of systematic exploration not only in Czechoslovakia but in other Central European countries as well. This First Expedition had an extraordinarily successful season. Nineteen sites in Bohemia were tested and yielded vestiges of fourteen different cultural phases ranging from the earliest Neolithic Age to the 12th century modern Slavic period. The success of the Expedition is to be attributed to the interest and coöperation of the State Archæological Institute whose director, Mr. Karel Buchtela, personally arranged the season's program. Mr. Buchtela's personal guidance and general advice have been of tremendous value throughout the three seasons. Sincere thanks are hereby expressed to him and to his associate, Dr. J. Böhm, as well as to the entire staff of the Institute.

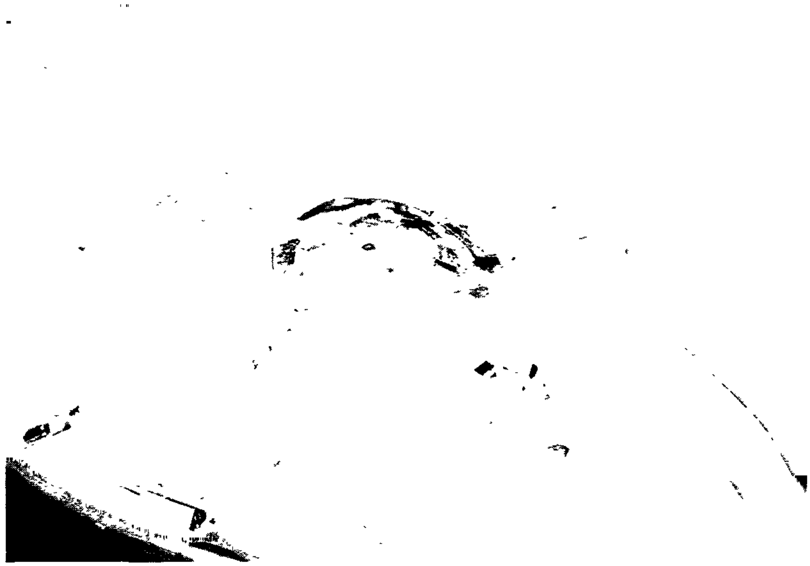
The Second and Third Expeditions had not only the support of the Institute, but were also officially sanctioned by the Ministry of Education through the kindness of Dr. Z.

Wirth and Dr. V. Dvořák, to whom great indebtedness is now acknowledged. General J. Fajfr, commander of the Czechoslovak Air Corps, is to be especially thanked for his kindness in arranging for airplane photographs of the site, to be made during the excavations. Acknowledgments are also made to Professors A. Stocký and J. Schránil of the Charles University in Praha, who have aided the work of the Expeditions by generous coöperation. The Expedition was met with sincere understanding, and the splendid attitude of the governmental and archæological authorities has afforded it three most enjoyable seasons in Czechoslovakia.

Preface

During the field seasons of 1930 and 1931 the major part of the time was devoted to the excavation of Homolka, located in Central Bohemia, some 21 km. northwest from Praha, the capital city of the Czechoslovak Republic. The name is commonly used in the Czech language to denote a small cone or hillock. Homolka is a rounded hill which rises to the height of 20 m. above the narrow valley just east of the village of Stehelčeves, county of Kladno. Having steep slopes on the western, eastern, and southern sides, it is connected on the south with the higher ridge just back of it by a low, broad saddleback which also affords comfortable access. The floor of the valley below appears originally to have been either swampy and occasionally inundated, or completely under water, as indicated by faint traces of natural terraces. According to local traditions a fishpond existed under the eastern slope of Homolka as late as the 17th century. At the present time the floor of the valley is filled with fertile alluvial deposits. The hill itself is composed of Algonkian filite, a soft and flaky shale, with occasional outcrops of quartz. The mantle of vegetable humus covering this rock foundation averages 20 cm. on the top of the hill and rises gently to as much as 60 cm. towards the retaining boundary lines along the slopes. As a property of the village of Stehelčeves, Homolka is being leased out as second grade farming land, under parcellation number

508/1, map of 1898. The present lessee is Mr. A. Šípek of Stehelčeves, who readily consented to excavations with the understanding that the hill would be restored to its normal condition. Owing to agricultural pursuits the crest of



Airplane view of Homolka, facing east. Cat. no. 253K

Homolka is set off by a sturdy boundary line which serves as a retention wall and also as land demarkation. The eastern side of the hill is terraced and thereby altered from its original shape. A considerable amount of quarrying has been carried on from time to time on the northern and western slopes, and the resulting damage has effaced a certain portion of archæological deposits originally present there. The northwestern side of the hill appears to have suffered most severely in this respect. Just south of the hill and immediately under it, east and west of the saddleback, two fields were lowered some time ago. In consequence, it was impossible to find any traces of the site which logically should have continued in both areas thus effected.

All the Central European Expeditions were in charge of

the writer and Mr. Robert W. Ehrich of the Peabody Museum of Harvard University. Several graduate students in anthropology from Harvard and Pennsylvania made up the staff. In addition, students of the American School of Prehistoric Research, under the direction of Dr. George Grant MacCurdy, participated in the work for several weeks during the major seasons. Local engineers, draftsmen, and preparators were engaged for technical tasks.

The start of systematic explorations at Homolka in 1930 was handicapped by the presence of standing cereal crops along the northern and southern edges. It became necessary to operate in the intervening area which was covered by a growth of alfalfa. The field procedure was gradually developed as crops were cleared, and in the middle of September practically the entire top of the hill was stripped bare. The principle of coördinate squares was applied in dividing the site into sections. The salient points were marked by steel pipes driven deep into the rock and protected with a stopper to keep them clear when not used for site poles. Individual sections were further broken into strips which were excavated along the same progression as a trench would be, but in alternate zones, so as to leave sufficient space for the disposal of humus. When two parallel strips were completely dug they were filled immediately, and the intervening space treated in a similar manner. While the rest of the area was still inaccessible, due to crops, ample space was gained on the top of the hill for deposition of dirt from the slopes. Thus all restrictions on expansion were removed. In the late season the top of the hill was one mass of humus carried there after stripping the edges of the crest. The excavating procedure changed as time went on. The discovery of certain fortification features necessitated the opening of large areas in the shortest possible time. Mistakes and experience guided the progress and led to the uncovering of the entire southern half of Homolka, in order to facilitate the recording and interpretation of certain structures which otherwise would have been cumbersome to handle properly. It was found that

operating in large areas afforded room for detailed work in excavating, photographing, and surveying and, above all, facilitated the reading and interpretation of the ground.

Upon removing the vegetable humus covering with light picks and hoes, the shale foundation of the hill was exposed and carefully swept with brooms and fine brushes. The humus itself yielded potsherds and other artifacts, but these were all in secondary position when lying within the thickness ordinarily turned by the blade of an average plough, a matter of some 15 cm. to 20 cm. On the crest of the hill the humus was disturbed, or turned, throughout its depth of 20 cm. so that the task of clearing it was speeded by the fact that it was not necessary to record the deposition of objects found in it. In the light gray shale under the humus dark spots of oval and circular shapes appeared. These marked the position of cultural deposits, either in the forms of individual pits which originally served as dwelling foundations, or as the floors of complete huts. Centuries of cultivation had destroyed their aboriginal top levels, leaving untouched only the portion which the blade of a plough or a hoe could not reach. Minute black spots turned out to be the remnants of wooden posts, long trough-like bands revealed the foundations of palisades with deep postholes underneath, and rows of other small spots designated the original position of gates and causeways into the fortress which was subsequently discovered. The pits were originally dug into the shale and the posts of huts as well as fortifications driven into it. After the abandonment of the settlement by the aborigines, the structures collapsed, partially filling the subpits under them and thereby preserving the material contained therein. Natural forces accelerated the filling up of the remaining cavities with surrounding débris, and in the course of time the entire settlement was covered. Agricultural activities, carried on at Homolka for probably several centuries, naturally destroyed certain parts of the old relics, but no one was particularly aware of the presence of such unique features until the excavations of 1930 were well under way. In excavating the deposits

proper the heavy tools were discarded, and digging knives, spatulas, and fine brushes exclusively were used. The pits were carefully watched for indications of stratification, but this proved to be of no help because sherds from the same vessels were often found vertically distributed throughout the pit and, indeed, in some cases even separated by what appeared to be sterile layers. It became evident that the pits had undergone a certain amount of "house cleaning" in aboriginal times and that stratigraphy, even if found, was of doubtful value. Definitely stratified occupation floors were found in one outstanding instance, namely pit complex number 33. A group of subpits belonging to the earliest period of the settlement was overlaid by two superimposed huts of different times. These were clearly defined by posts and their individual interior arrangements. In complicated pits the material was kept in separate batches as it was found and the records were made in accordance with current needs. Field notes were kept on stiff cards 10 cm. by 15 cm. in size, and were always written directly in the field. Measurements were taken always on right angles with the aid of the coördinates. A contour map was made on a scale of 1 : 500 and from it a site map in 1 : 100 was drawn with all details plotted therein. Theodolites and tachiometers were used for all the surveying work. Field sketches were made of details and small features, and then redrawn in uniform scale for permanent records. A great deal of recovered pottery was restored in the field laboratory.

The top of Homolka resembles a roughly pointed horseshoe, the greatest length of which is just under 100 m. and the greatest width 60 m. The fortified settlement located there belongs to the so-called "Nordic" phase of Neolithic culture, approximately datable between 2,000 and 1,800 B.C., which represents the closing stage of the New Stone Age in Central Europe. This date is merely an estimate, since there are no reliable correlation factors for such a remote time in European history. All indications point to a peaceful abandonment of the site by the "Nordic" aborigines. The reason for it

remains unknown. Homolka then remained unused by man until the 11th or 12th century A.D., when it served as a burial ground for local Slavic people who placed a row of nine graves directly on the crest of the hill, causing at the same time not

Plan of Homolka. Cat. no. 368.

Culture pits numbered consecutively from 1 to 147. Huts lettered A to S. Hearths in pits and huts indicated by dotted lines. Broken lines connect posts of individual huts.

the slightest disturbance of the "Nordic" deposits. Modern cultivation has been carried on for several centuries on the hill. In spite of the ploughing and quarrying operations, the architectural and material cultural remains of the fortress preserved to the present day yield a remarkably rounded record

of the life and civilization extant in Bohemia during the opening centuries of the second millennium B.C.

In order to indicate properly the true significance of Homolka in its historical setting, however, it is necessary to present the background of Neolithic archæology in Bohemia, of which it forms a part.

The Neolithic Period of Bohemia

Historical Sketch

Bohemia, the western province of the Czechoslovak republic, occupies an important geographical territory in Central Europe which forms a logical meeting ground for several natural highways. The Upper Elbe Basin includes the continental water shed and makes Bohemia accessible by the valleys of several rivers, practically all of which rise there to form affluents of the Elbe. The Danube, the Oder, and the Saale are, furthermore, all within comfortable reach. These river valleys afforded natural avenues of ethnic and cultural movements in antiquity, while the loess stretches of Central Europe provided ready and fertile ground for the early hoe culturist. In Bohemia both of these factors played important roles, and it was perhaps natural that the Upper Elbe River Valley should have become an early seat of the Neolithic peasants. The archæology of Bohemia presents a pattern of culture history in Central Europe from the Neolithic Age on to the Mediæval Period. Present evidence points to a lack of definite cultural development between the Old and the New Stone Ages. Positive evidence, adduced from the earliest traces of Neolithic economy, documents new ethnic and cultural arrivals. Bohemian authorities [1] agree that the New Stone Age culture was diffused into the Upper Elbe Basin as a complex from southeastern Europe. This geographical derivation, however, is used in a broad sense and at the present time lacks specific connotations. The want of systematic fieldwork in certain intervening regions between the Balkans and Central Europe is responsible for the existing difficulties.

[1] Buchtela, Niederle, Schránil, Stocký.

The history of Bohemian archæology, now a record of a hundred years, had an interesting development. Up until the closing years of the past century the School of Romanticism dominated the field. In the late nineties Buchtela and Niederle layed the foundations for a modern school of thought which soon rose and centered about the Charles University of Praha.[1] In 1899, Buchtela [2] established the existing system of relative chronology in a critique of the works of Píč [3] who, at that time, was in control of most of the excavations.[4] The system was elaborated in a handbook published by Buchtela and Niederle [5] eleven years later, and is now fully recognized in principle.[6] In recent years, Stocký [7] and Schránil,[8] both guided by their own researches, have based their works upon Buchtela's teachings. Childe,[9] the most productive English writer on Central European archæology, has given the greatest impetus to the modern Bohemian thought in archæology outside of Bohemia. With the aid of a sound system and a large group of devoted workers the post-war progress of Bohemian archæology was rapid. Fieldwork by the State Archæological

[1] Became known as the "University School" in contrast to the "Museum School." (See note 5.)

[2] Buchtela, Karel, *Vorgeschichte Bohmens.* Praha 1899.

[3] Píč, J. L., *Starožitnosti země české.* I. Praha 1899.

[4] Píč did not believe in the existence of a Neolithic Period in Bohemia. As head of the archæological division of the Bohemian Land Museum (now the National Museum) in Praha, Píč had access to most of the material, dug a great deal, and perceived, it seems, some of the guiding differences in the various phases of local cultural development. However, he blocked his own opportunities for real contributions by relying on outside comparative observations rather than subjecting his fundamentally erroneous convictions to the weight of the new evidence and interpretations advanced by Buchtela.

[5] Buchtela, K. and Niederle, L., *Rukověť české archaeologie.* With a supplement from Matiegka, J., on Physical Anthropology of Bohemia in Antiquity. Praha 1910.

[6] Buchtela worked with little archæological material. An accomplished student of art and a devoted lover of antiquities, he formulated his system by careful field observations in excavations, detailed study of all European archæological literature and above all by his uncanny sense for art styles. In the beginning, certain parts of his system were only hypotheses, but they were all upheld by actual discoveries as time went on.

[7] Stocký, A., *Pravěk země české.* First volume. Praha 1926. French translation.

[8] Schránil, J., *Vorgeschichte Böhmens und Mahrens.* Berlin and Leipzig, 1928.

[9] Childe, V. G., *The Dawn of European Civilization.* New York 1925. *The Danube in Prehistory.* Oxford, 1929.

Institute, the National Museum, and a number of provincial museums has broadened the understanding and knowledge of the various phases of antiquity, and has also led to concentration upon outstanding specific problems. A great deal has been accomplished so far and much is being planned in the way of systematic research for the future. Undoubtedly, Bohemia will retain an important place in European archæology.

Culture Sequence [1]

Because of the prevailing lack of any evidence, positive or negative, which would throw light on the possible existence of the so-called Transitional or Mesolithic Period in Bohemia, the disputed theory of "hiatus" [2] must be reaffirmed. The Neolithic period was ushered into Bohemia by a new arrival of people who brought with them a culture radically different from anything that had previously existed there. Archæological records, as early as the first half of the third millennium B.C.,[3] attest the presence of a primitive economy, based upon hoe culture, animal breeding, and hunting. From that time on the country was continually inhabited. Although the stamp of general cultural expression and the ethnic element itself changed with time, the culture history of this small land shows a remarkable record of what a greater part of Central Europe experienced in antiquity.

Buchtela [4] distinguished three major subdivisions of the Neolithic Period in Bohemia:

1. Older, purely Neolithic stage, characterized by the Incised pottery.
2. Younger, purely Neolithic stage, distinguished by the Stroked ware.
3. Transitional stage, which included the Jordansmühl,

[1] The limits of the present paper preclude a thorough treatment which, however, is to be embodied in the final report on the subject.

[2] Stocký, A., *Pravěk země české*, Praha 1926, pp. 33 and 34. Also Childe, *The Danube in Prehistory*, p. 17.

[3] Approximate date, quite conservative.

[4] "Vorgeschichte Bohmens," Praha 1899 and Rukověť, Praha 1910.

"Nordic,"[1] Corded, and Bell Beaker phases of ceramic styles.[2]

The Older, purely Neolithic Stage, is represented by the Incised pottery, often called the Banded ware. The vessels are of globular or semiglobular shapes without intentionally flattened bottoms, and have no distinct necks. Decoration consists of finger and fingernail impressions, incising with the aid of a tool and dimpling. Positive appliqué relief often appears. The scroll, chevron, and meander are the most constant decorative motives. Lugs and lug handles are common. Late in this stage painted pottery, apparently the oldest in Central Europe, is found. The paint is of mineral nature, mixed in resin and applied after the firing process. The pottery technique indicates a full knowledge of the Neolithic ceramic craft. The clay received due treatment in levigating, mixing, and tempering. There is no evidence of primary experimentation. Bone and antler artifacts include various points, awls, needles, and potters' decorating and polishing tools. In stone implements the shoe-last celt, predominantly imperforated, usually of slate, is characteristic. Knife blades, scrapers, borers, and sundry tools of flint and other hard stone are fairly common. Milling stones, querns, abrading and whet stones, mauls, pounders and hammers, usually of quartzite, sandstone, and limestone are also common. Ornamental objects, such as beads and discs of shell and bone, also appear. Animal bones found in culture deposits of this stage include those of domesticated dogs, cattle, sheep, hogs, and goats. Bones of game represent the common Central European varieties. The bearers of this culture lived in regular settlements, as a rule in river valleys, in elevated places protected from periodic floods. Their dwellings were semisubterranean structures built of twigs and branches

[1] The term "Nordic" was chosen by Buchtela because of the appearance of certain cultural elements in this phase derived from the north. The designation is now unsatisfactory, but is so widely used that it seems best to retain it for the purpose of a preliminary report.

[2] The cultural foundation of this stage lies fully within the Neolithic sphere, but its culminating parts witnessed the earliest appearance of Copper and even Bronze. The general cultural character, however, is not Eneolithic or Chalcolithic.

with walls of clay plaster somewhat on the principle of wattle and daub construction. At the present time remnants of these dwellings are found in forms of so-called culture pits, into and above which the original structure had collapsed. Graves are rare. Contracted skeletal burials and cremations with furniture have been recorded. The mode of life of the people responsible for this early stage of the Neolithic culture can be reconstructed from the incomplete records which have been preserved to the present day. Organized social life is attested by the nature of the settlements. The economy may be interpreted as one of rather simple hoe culture of such cereals as wheat, rye, and barley, breeding of domesticated cattle, hogs, sheep, and goats, possibly limited trade relations, and hunting and fishing.

Outside of Bohemia, the Neolithic incised Pottery culture is found throughout the Danubian Valley [1] in central and western Germany,[2] in France,[3] in Belgium,[4] and apparently also in England.[5] The Bohemian material seems to contain certain archaic elements which do not appear elsewhere. Yet this culture could hardly have developed there, since it appears from the very beginning as a well-rounded complex and there are no indications of Neolithic occupation preceeding it. The question of origin of the Incised ware is still open. In the case of Bohemia it seems unavoidable to treat it as a diffusion from outside. The region of the Lower Danubian Valley or, more definitely, present-day Yugoslavia, appears to be most acceptable as the original centre of this diffusion. How the presence of Incised ware is to be explained there remains to be determined by future systematic researches. In the light of existing archæological knowledge, and in view of the geographical nearness of Yugoslavia to Anatolia and

[1] Moravia, Slovakia, Hungary, Austria, Yugoslavia, Bulgaria.

[2] Silesia, Saxony and Thuringia have practically the same ware as Bohemia. In the Rhine Valley, however, the situation is different due to various cultural cross currents.

[3] The Omalian phase of the Paris Basin and northern parts of France.

[4] Particularly in the Meuse Valley, the Omalian phase.

[5] Especially recent, hitherto unpublished discoveries in central England. Information supplied by Dr. H. O'N. Hencken of Harvard.

the Aegean, it seems permissible to postulate the Incised Pottery culture as a diffusion into Bohemia from the south-eastern parts of Europe.

The Younger, purely Neolithic period is represented by the Stroked pottery phase. Typical are pear-shaped vessels with tapered and up-turned lugs, cauldron forms, and plain bowls. Decoration consists of stroking effected with a blunt implement of wood or bone which was operated at a slant. Motifs are restrained to chevrons, checker-board design, and garlands. The patterns are formed by parallel lines or bands of stroking. The forms were derived from the Incised prototypes among which, indeed, the idea of stroking is suggested in certain decorative elements.[1] The developed, advanced shapes and modes of decoration in Late Stroked ware, however, seem to suggest new influence. While these new forces may be attributed to the prevailing cultural diffusion from the "southeast," [2] the fact remains that basically the Stroked pottery phase is closely akin to the preceding Incised phase. Culturally speaking, the two differ in pottery only. The stone and bone implements remain essentially the same in form and function. The mode of life and general economy are very similar. Burial customs are also alike, though it would seem that cremation was a more common practice during the Stroked pottery phase.[3] There are no apparent ethnic differences between the two groups. In a number of instances it has been observed that village sites of the Incised pottery phase furnished evidence of non-violent intrusion of the Stroked pottery phase in chronologically and typologically late deposits.[4]

In comparison with the Incised ware the Stroked pottery has a much more limited geographic distribution. To the east it reaches only as far as Moravia and western Poland; to the north it is found in Silesia, Saxony, and Thuringia; and a

[1] New light on this point is furnished in the material excavated by the State Archæological Institute of Praha in Bubeneč in 1931. Unpublished as yet.

[2] Particularly plastic art, such as figurines.

[3] Eighteen graves found at Bubeneč. See note 22.

[4] Stocký: Pravek, p. 75. Also personal field observations in Bohemia.

somewhat akin, though not directly related, group appears in the Rhineland. Moravia and western Poland appear to be the eastern periphery of the distribution of true Stroked pottery, and western Saxony and Thuringia seem to play a similar role in the northwest direction. Silesia and Bohemia remain as the only logical parental regions. Geographically, the two are separated by the Sudeten range, but their physiography and Neolithic culture history are strikingly similar. Bohemia enjoys a greater degree of isolation than Silesia and also has more prototypes for the Stroked pottery shapes and decoration.[1] Inasmuch as the Stroked pottery phase indicates a close cultural allignment with the Incised pottery culture through certain definite steps of gradual development in Bohemia, it seems superfluous to look for the exact spot of the original ideas which gave rise to the occasion. Fundamentally, the Stroked pottery phase belongs within the sphere of the Older Neolithic Period of Bohemia.[2]

The Transitional, or truly Younger Neolithic period, includes four phases which are marked by four different ceramic expressions. Two of these were related to the indigenous cultural stock, that is, the Banded pottery group, and two represent infusions from radically different spheres of development. These four, in sequence of strictly local chronology[3] are: The Jordansmühl phase,[4] the so-called "Nordic" phase, Corded pottery phase, and the Bell Beaker phase.

In the sense of general cultural expression and specific chronological setting, the Jordansmühl phase belongs within the sphere of the Central European Neolithic Painted Pot-

[1] The so-called Šárka type is a good example.

[2] The term "culture" must be understood as a designation of the total material and spiritual attainment of a given people within a certain period of time. While in archæological application only material elements are referred to, great care should be taken not to call an individual trait, such as pottery alone, a "culture." In this sense the entire Neolithic period represents a culture, and the individual subdivisions, distinguished by changes in separate traits only, represent the various phases of it as the historic evidence demands.

[3] It is important to keep in mind the significance of regional differentiation in a geographic environment which tended to foster individual areas of cultural development and produced sub-centers within given spheres of development in Neolithic Europe.

[4] Named after a site found near the town of Jordansmuhl in Silesia.

tery.[1] Paradoxical as it may seem, however, this particular phase lacks the element of ceramic painting. Forms of vessels and stone implements, nature and general character of economy, as well as the racial element, are closely related to the Older Neolithic period and display again the significant factor of peaceful development and expansion. It is in association with the Jordansmühl material that the earliest known traces of copper, the first appearing metal, are found. Spectacle-shaped earrings, simple rings, and small spirals appear at this time in small quantities, apparently representing imports from outside, since there are no indications of local metallurgy. It would be improper to interpret the first indications of the knowledge of copper as a trait of a Chalcolithic or Eneolithic period, since local metal industry as such cannot be satisfactorily proven until the beginning of the true Bronze Age.

Certain Jordansmühl pottery forms exhibit a likeness to the Incised and Stroked vessel shapes, but the series represents predominantly new developments. The pitcher, for example, is a radical deviation from anything preceding, and marks the first appearance of this form in Bohemia. It has usually two handles, though sometimes but one. Slender jugs with three to five handles, pedestalled vessels, elongated pans, plain bowls, and cups represent the other typical forms. Decoration consists of incised and finely engraved lines in triangular, chevron, and meander designs. The pottery is made of selected clays, carefully tempered and, as a rule, well baked. Bone and stone implements, in the main, are about the same in character as in the older phase. The shoe-last celt, still made of slate, prevailed, although it became somewhat flattened and perhaps more frequently perforated. In economic and social factors, the same elements of pure Neolithic culture are observable. It appears that trade played

[1] In older literature usually referred to as "Lengyel" Complex, after the Hungarian site excavated by Wossinsky. Tompa, F. "Neolitische Band Keramik in Ungarn." Archæologia Hungarica, Budapest 1931, has substituted the term Tisza (after the river of the same name) for Lengyel. Owing to regional differentiation within the sphere, it seems advisable to use the designation of Central European Neolithic Painted Pottery when the culture is referred to in broad terms.

a greater role than before. The early appearance of occasional copper trinkets found sporadically in association with Jordansmühl material should be attributed to outside contacts, or more definitely to barter.

In Bohemia, Jordansmühl traits began to appear concurrently with the Late Stroked pottery development.[1] Schránil [2] considers it to be a branch of Late South Moravian Painted ware which came into Bohemia by way of Silesia. Grotesque plastic art, so prominent in the South Moravian Painted ware, is perhaps the most significant indication of this relation. The geographic penetration of the Stroked pottery group into Moravia was checked by a further development of the Painted ceramics, which stands in a definite genetic relationship to the oldest Neolithic phase in Central Europe, namely the Incised ware. Jordansmühl is being interpreted as the "paintless" subgroup of the South Moravian Painted Pottery phase, which from the standpoint of chronological setting began to develop at the time of the advanced Stroked pottery phase in Bohemia.[3] It is possible that the Jordansmühl development represents not a loss of painting, but rather an early departure from the ultimate trend of the parental culture stage, or a simple process of divergence. However, even if the absence of painting on vessels should be proven as a definite loss of a culture trait, such a phenomenon would not be without historical comparisons, nor would it present an outstanding riddle.[4]

The Jordansmühl type of pottery is found in Moravia,[5] which appears to be the region of its original rise, in Silesia to [6] the north of it, and in Bohemia.[7] A related group, known as Münchshöfen, has been found to have existed in

[1] Stocký, Pravěk, p. 76.

[2] Schránil, Vorgeschichte, pp. 55, 56.

[3] Ibid.

[4] There are several examples of the losses of useful culture traits in recent ethnology.

[5] Stocký, Pravěk, pp. 145, 146.

[6] Seger, H., Die Keramischen Stillarten der jüngeren Steinzeit Schlesiens. Breslau, 1916, pp. 1–81.

[7] Stocký, Pravěk, pp. 75–81.

Central Germany.[1] The foundation of this phase of advanced Neolithic development had its roots in the earlier cultural stage, and its history throws light on the prevalence of diffusion from the southeast into Central Europe. Up to this time there is nothing in the known archæological remains of Bohemia which would furnish evidence of relations with the regions to the north of it, unless it should develop that the Stroked pottery phase, in spite of the latest discoveries,[2] has a genetic affiliation with the Early Neolithic history in the Rhineland.[3]

In Buchtela's system,[4] Jordansmühl is followed by the Corded pottery phase, that in turn by the so-called "Nordic" development, and finally by the Bell Beaker phase which closes the Neolithic history. This scheme was adopted by Stocký.[5] Schránil,[6] however, was the first Czech archæologist to deviate from Buchtela's chronology, when he placed the so-called "Nordic" before the Corded phase. His interpretation was based upon a greater amount of material and analysis of Moravian finds. Schránil's revision is generally accepted and it was the good fortune of the Harvard-Pennsylvania Expedition to find supporting evidence at the site of Homolka. It becomes expedient, then, to discuss the so-called "Nordic" phase next, as the one succeeding Jordansmühl and representing the closing stage of the Neolithic culture history in Bohemia. While its ergological structure is in reality a direct outgrowth of the same general culture bases which prevalied throughout the New Stone Age period of Central Europe, the "Nordic" phase marks the first significant infusion into Bohemia from the north, in contrast to the previously predominant trend from the southeast. It is to this important phase of Bohemian antiquity that the site of Homolka belongs.

[1] Menghin, O., Nachtrag in Hoerness, M., Urgeschichte der bildenden Kunst in Europa, etc., Wien 1925, p. 788.

[2] Bubeneč.

[3] In Western Germany, Incised ware was preceded, it seems, by pottery somewhat resembling the Stroked of Bohemia.

[4] Vorgeschichte and Rukověť.

[5] Pravěk.

[6] Vorgeschichte.

As will be shown later, new light on its chronological position was found in the course of the Harvard-Pennsylvania excavations.

In the Bohemian "Nordic," five groups of ceramic wares have been distinguished by Stocký:[1] globular amphoræ or the Mecklenburg-Brandeburg group, funnel-necked breakers and collared flasks, Bernburg type, also called Anhalt or Latdorf, canellated or fluted ware, Ljubljana (Laibach) Moor group. The first two are thought to have been derived from the north; the third appears to be a mixture of southern and northern traits; the fourth represents a southeastern factor; the fifth seems to be derived from the Lake Dwellings of the east Alpine region. A certain amount of mixture of these types, found in several sites, indicates somewhat of a cultural turmoil in contrast to the previous peaceful conditions.

"Nordic" settlements in Bohemia seem to be concentrated on hilltops or in higher elevations, as if to insure natural protection or to facilitate the building of artificial means of defence. Definite huts with posts and mud walls were the usual type of dwelling. Such useful industrial arts as pottery making and the production of bone and stone implements were on a high level. Trade appears to have expanded during this phase, and amber became the most important commodity, having been brought into Bohemia from the Baltic. The economic structure remained about the same as before. Simple hoe culture, stock raising, hunting and fishing, and limited but steadily growing barter with regions to the north and to the southeast, characterize the "Nordic" phase and reflect the state of culture of the Late Neolithic Man in Central Europe. With this phase, however, the peaceful progress came to an end. Bohemia was invaded from the north and the west during the later part of the "Nordic" phase. The first infusion may be detected in the form of northern pottery styles known as globular amphoræ, funnel-necked beakers and collared flasks. All these belong within the "Nordic" phase proper. Then followed the Corded ware influx, again

[1] Stocký, Pravěk, chapter on Nordic pottery, pp. 93–116.

from the north, and finally the Bell Beakers, which were introduced from the west.

Corded pottery in Bohemia is found only in graves. It is to be expected that graves alone cannot give satisfactory evidence of the true state of culture history of the period which they represent. Even the graves themselves have been found only in small groups and not in large cemeteries. It is thought that the people responsible for these burials were nomadic traders [1] who did not settle anywhere for any length of time. No traces of even temporary camp sites have been found.

The pottery has four characteristic forms: the so-called beaker, with slender cylindrical neck of considerable height; the so-called amphora, with large handles on the body and usually small handles set at the base of the neck; the pitcher, a local product rather than a diffusion from the north; and the plain bowl. At first decoration consists of impressions of a twisted cord, usually in zoned bands; later on imitation in incised technique is characteristic. Perforated hammer axes are typical. Collars of animal teeth and shell are quite common. Copper trinkets also appear, but it is doubtful that these came from the north. Interments are in plain grave pits, with no superstructure, although in Bavaria tumuli do occur.[2] Owing to the fragmentary evidences of Corded ware culture, little can be said about economy or social life. Outside of Bohemia similar ware appears in Moravia, Poland, and eastern and central Germany.

The Bell Beakers represent the culminating phase of the Neolithic period of Bohemia. The term is derived from the rather striking form of vessel which resembles the shape of a bell. The origin of this ware, which has a wide distribution in Europe, is still uncertain, although the prevailing opinion would have the Iberian Peninsula as the centre. In the case of Bohemia, Bell Beakers represent an unmistakably new arrival, but from what direction remains as yet unsettled. As in the case of Corded, so again the Bell Beakers are found in

[1] Salt may have been the main commodity in such trade.

[2] Reinerth, H., Chronologie der jungeren Steinzeit in Suddeutschland. Augsburg, 1924.

Bohemia in graves only. Skeletal interments in plain pits, accompanied by vessels and other furniture, form the only evidence so far known. Yet these burials have been found in large enough numbers to suggest a long period of time during which these people remained in Bohemia.

Pottery of this phase has two characteristic types, the chalice or bell-shaped beaker, and the multi-footed bowl. Domestic imitation produced certain varieties which did not equal the excellent workmanship of the original ware, but which help materially in dating. With the Bell Beakers metals began to appear in Bohemia more regularly: copper, gold, silver, bronze, in the order named. In the beginning they represented purely imports from outside, as there was no local supply of copper, and the forms themselves indicate Mediterranean origins. No molds for metal casting have been found in association with Bell Beaker deposits in Bohemia thus far. There are no indications of local metallurgy until the following culture phase, that of Únětice (German Aunjetitz) or the First Bronze Age, was established. In reality metal objects were relatively rare. The Bell Beaker people who roamed through Central Europe in search of metal sources, presumably copper, have been called "prospectors." [1] In Bohemia they not only failed to locate copper mines, but their individual cultural expression was soon lost in the local growth which, at the time, was laying foundation for the development of the striking Únětice phase of the Bronze Age.

With the Bell Beakers the Neolithic Period of Bohemia came definitely to an end. During the closing phases influences from three cultural groups were at play. The "Nordic" phase represented purely local growth which assimilated admixtures from surrounding regions. The Corded ware clearly indicates new arrivals, as does the Bell Beaker group. Neither of these two seemed to have had long periods of independent duration in Bohemia. It was the surviving "Nordic" cultural stamp which occasioned an amalgamation of the various styles coexisting in Bohemia at the very end of

[1] Childe: The Dawn of European Civilization, p. 187.

the Neolithic period. "Nordic" was a domestic product, fully within the spirit of preceding cultural tradition. It absorbed outside influences readily enough, but without any appreciable changes of its own expression. The Corded and Bell Beaker groups both represented sudden invasions, but neither existed for long. Certain elements from both of these have been adopted into the local setting and the new changes produced the Únětice phase, or the first true metal stage, the classical central European Bronze Age.

The recognized individual phases of the Neolithic Period in Bohemia do not represent sharply defined or contrasted developments, stratified deposits, or a gradual evolution. While a fundamental sameness is apparent throughout the period, currents of general cultural diffusion were felt from time to time which occasioned certain changes. Just how new styles came into existence cannot be explained on the basis of existing material, and such interpretations as have been offered are not entirely satisfactory.[1] It will perhaps never be possible to elucidate the causes and actual forces involved in such phenomena as the beginning of stroking or the earliest appearance of the pitcher. The experimental stages in both cases will probably never be recognized or isolated by the archæologist. The most important need is to determine the relative, not absolute, chronological relation of the various phases within a given period of the history of human culture. In the case of Bohemia this seems to have been done. A number of important tasks remain to be considered. In this respect, the "Nordic" phase stands out as an immediate need, inasmuch as it is necessary to inquire into the question of intra-chronological sequence of the derived and infused elements which came in from the southeast, east, and the north. Up to the present time no large settlements or cemeteries of this phase have been completely excavated. The majority of the material comes from small groups of dwelling pits or graves, and a small part from chance finds. It is natural that small units could not yield sufficient

[1] Ethnic and cultural movements did not necessarily have to go hand in hand.

light on stratigraphic or chronologic order. Typological series have been established, but inasmuch as such procedure must be done in the laboratory it cannot be entirely satisfactory. Lack of funds usually hinders large scale field operations. Homolka was really the first site in Central Europe of its size and nature which was systematically and completely explored. It was the good fortune of the Expedition to find new evidence on the culture history of the "Nordic" phase, stratigraphic documentation of pottery sequence, and heretofore unknown records of the general mode of life in the closing stage of the Neolithic Period in Bohemia. This, in our time reckoning, can be placed in the first century of the second millennium B.C.

Results of Excavations at Homolka

Material Recovered

Pottery, the cultural index and rough calendar of the archæologist, was found in large quantities. Its qualitative study is being completed with important results. Nine major classes of vessels, based upon shapes and function, have been recognized. Each class, in turn, includes deviations within the type which it represents. With the existing architectural features it was possible to determine the youngest deposits directly in the field; and in certain unusual instances the oldest deposits were unmistakably identified. The intermediate material was not quite as conveniently recognizable in the site, but has been fairly sharply distinguished in the course of laboratory studies. The Homolka product, throughout the duration of the occupation of the site, is a strikingly homogeneous ware, made of selected and apparently partially levigated clays. In the tempering material, sand grit and mica predominate. Textures of vessels, naturally, vary with the individual type of function, but fine texture really predominates. The firing on the whole is quite good. Although there is a total absence of slip the burnish, usually of high grade, acts as a substitute and produces what might be called a false or mechanical slip. Coiling seems to have been the main technique in pottery manu-

facture. The burnish may have been effected with the aid of either stone or bone tools, since a large variety of both was found. The decorative technique seems to have been executed with the aid of bone tools. Although undergoing a certain process of local growth, the pottery native to Homolka exhibits a peaceful state of affairs. During this time only the originality of the potter and his desire to experiment brought about deviations from the trends set by the cultural understructure which rooted in historically preceding styles. The oldest Homolka pottery shows faint but significant affinities with the Jordansmühl phase. Typical pieces are jars, somewhat resembling the pithos form of the Aegean, plain bowls, low pitchers, cups, and mugs. The surface finish consists predominantly of rough or fine rubbing among jars and large bowls, and a burnish or fine smoothing among the smaller vessels. Decoration is restricted to deep grooving arranged in a band pattern. The plastic appliqué work is rather crude. Ridge lugs and broad band handles are common, but the ansa lunata handle, so characteristic of the phase, is not present in the oldest Homolka deposits. It appears in a fully developed form in what may be designated as the intermediate ware, a direct continuation from that which preceded, distinguished by certain refinement with a greater variety of shapes. The jug, usually called "amphora" by Czech archæologists,[1] seems to appear for the first time. Decoration is more common, although still largely restricted to the grooving technique, while appliqué is more finely executed. The pitcher and cups become relatively taller and exhibit a greater variety of form. Bowls seem to have gone through a process of free experimentation which resulted in certain grotesque forms, and in the striking changes of the lug-handles. The entire development shows marked traces of new influences, while on the contrary, everything points to an unbroken continuous existence. In the youngest deposits the local ware still prevails as it existed in the intermediary stage. Early elements persist. For the first time in the history of

[1] An erroneous but established term which is difficult to change.

Homolka, however, new ceramic traits, totally different from the style existing there, appeared. Two streams of diffusion, representing different geographic regions, were responsible for the introduction of these innovations. One came from the south, or more definitely from the region of the east Alpine Lake Dwellings, known as the Ljubljana (German Laibach) Moor phase. Footed bowls are their most characteristic index phenomena. At Homolka, judging by the differences in technique of production and of the physical nature of the specimens, they appear to represent partly imports and partly domestic imitation. In decoration they stand out in sharp contrast to anything native to the site. The other foreign elements came from the north and have affinities with the so-called Bernburg-Latdorf group, which, according to Stocký,[1] represents an originally southern culture nucleus. They are also partly related to the globular amphoræ of central Germany. There are no traces of the funnel-necked beaker, the collared flask, the Bernburg "drum," nor indeed of the true Bernburg pitcher. These wares, which did not appear at Homolka until the latest stage of its development, and are unmistakably assignable to the northern groups, differ from the domestic product in several important aspects. It seems that every example represents an acquired ware, inasmuch as the difference in technique and decoration, as well as structural composition, is something radically foreign to anything ever produced at Homolka. Yet, there is very little of this material there and not a single vessel of the group could be restored. In two sections of Homolka superimposed deposits with stratified levels have been found. These, naturally, should yield helpful light on the sequence of material. It was in a section of three occupational levels, representing two superimposed huts above a group of dwelling pits belonging to the earliest stage of Homolka's cultural history, that material derived from the north was found in the top level, or the youngest deposit. In addition to this stratigraphic evidence, an analysis of the ceramic styles shows

[1] Pravěk, p. 94.

clearly that the traits representing northern derivation are the latest at this site. It seems that the two infusions, northern and southern, appeared at about the same time, and it is not possible, up to the present at least, to determine which was the earlier one.

The question of whether or not the foreign elements are to be accounted for by direct contacts, stray infiltration, or secondary derivation, cannot be answered satisfactorily. Trade between the northern and southern sections of Europe prospered during the existence of the Homolka settlement. Bohemia was really the key approach to the Elbe-Danube route. Homolka's fortifications suggest a certain unrest and the necessity of protection for the local people. Both the Corded and Bell Beaker ware people are considered to have been traders who, with the exception of graves, left no vestiges of their economy. They seem to have been assimilated by native folk, who would logically have to be affiliated with a similar ethnic and cultural stock such as the aboriginal settlers of Homolka. It must be remembered that, although the Corded and Bell Beaker groups are later than the "Nordic," the three coexisted for a time in much the same way that the earliest "Nordic" was somewhat contemporaneous with Jordansmühl. It was the amalgamation of the several strains of cultural development in the closing phase of the Bohemian Neolithic that laid the foundations for the rise of the earliest Bronze Age period in central Europe. The foreign elements found at Homolka may well represent a secondary derivation, which would explain the paucity of the northern traits on one hand and the few cases of striking similarities in physical structures in the southern ware on the other. The most significant factor is the dating of these foreign appearances, which are late and exert no influence upon the ceramic styles of Homolka Proper. Another important factor is the presence in the latest deposits of certain elements of form which later characterize Early Únětice (formerly Pre-Únětice), the first phase of Bohemian Bronze Age I. Profiled rim bands in a variety of shapes, pouch-formed cups, and the shapes and

position of handles represent this development which is purely a local growth and, therefore, historically important, inasmuch as it bridges the traditional survival tendency from the Neolithic into the earliest Bronze Age. Ŭnětice itself grew out of a complex foundation and shows in its ceramic forms the various styles prevalent in Bohemia at the end of the Neolithic, but the rôle of the Nordic seems to be brought into greater prominence than heretofore on the basis of the Homolka material. Especially interesting is the prevalence of cultural continuity, the existence of which should enable the archæologist to reconstruct the history of the Neolithic and Bronze Periods of Bohemia in great detail.

Besides pottery, quantities of bone and antler work have been found. There seems to be no distinction in types insofar as dating is concerned, except that antler axes, perforated, do not appear in the earliest deposits. On the other hand, certain specialized tools, such as weavers' bodkins and shuttles, seem to belong to the latest stage. On the whole, the bone, antler, and horn artifacts are sufficiently rich in type to serve a large variety of functions. They are, moreover, extremely well manufactured. Interesting classes, such as arrow heads, buttons, and fine points are present in considerable quantities and attest excellent skill and minute care. Awls, chisels, needles, plain points, picks, spatulas, and spade shapes appear in various sizes. Several pieces, in addition, indeterminable as to function, were found. Animal bones frequently show marks of cutting, compressing, or other impact. Often fragments of splinters of bone have been utilized as tools without being shaped to a conventional form. Stone implements were comparatively scarce. Rather ill-defined scrapers and knife blades, in addition to chips and flakes, represent artifacts made of hard stone. No flint arrow heads have been found. In general, the flat celt predominated. One fragment of a perforated, triangular shaped, round-polled celt, and one example of an incomplete polygonal ax, are the only exceptions. The celt shows strong resemblance to the shoe-last form of the earlier Neolithic

phases, but is broader and flatter. It has not been possible, as yet, to establish its typological sequence, but there seem to be certain definite leads which should make a seriation possible. The celts are mostly of slate and related stones, well polished, and show marks of liberal use. Polishing, rubbing, and whetting stones, as well as milling and crushing stones, of sandstone and limestone, are common. Hammers, mauls, and heavy grooved sledges were made of quartzite. Perforated shale discs are quite characteristic. Polishing pebbles are numerous. With the exception of quartzite, all hard stone materials had to be brought to Homolka. It is interesting to find such a relatively small quantity of celts, and the total lack of Nordic battle axes is really surprising. Yet other stone artifacts are well made and quite numerous.

In addition to the material already described, shells of glycimeris, from the Adriatic or Mediterranean, used as ornaments, unio shells for scraping, perforated animal teeth, baked clay ladles, spindle whorls, loom weights, and two figurines were found. These, with the addition of animal bones, wall plaster, a few fragments of human bones suggesting anthropophagy, and a cremated burial, complete the list of cultural objects. Many of these are extremely important. Thus, for example, the Mediterranean shells document trade relations with the south; clay ladles, again, attest southern cultural affinities: spindle whorls and loom weights historically throw the first direct evidence on the existence of weaving in Bohemia;[1] the figurines are especially important, not only as a link with the preceding phases and the southeast in general, but specifically as an indication of a cult which is suggested by their deposition in a separate extension of a dwelling foundation; animal bones have been studied by Professor Glover M. Allen of Harvard,[2] and show the following to be represented:

Domesticated: Cattle, pig, sheep, dog, and possibly cat.
Wild: Red and roe deer, red fox, beaver, badger, cat, otter, hare, bear, horse.

[1] Sherd whorls are known in Stroked.
[2] Details to be published by Professor Allen in the final report.

Birds: Goose, crane (?), black cock (synsacrum of a large gallinaceous bird).

Miscellaneous: Frog, hamster, hedgehog.

The wall plaster has chaff temper which, it is hoped, may identify the cereals used by the aborigines of Homolka; the fragments of human bones, jaws, skull, and long bones give interesting suggestions of canibalism, inasmuch as the fractures seem to be the results of artificial impact rather than due to natural causes; the cremated grave is the only sample of burial found in the site, and is appreciated in view of the fact that a determined search to find the cemetery belonging to Homolka met with total failure. In addition to the culture *Mobiliere*, Homolka gave up an unusual record of the mode of life of its inhabitants, such as hut foundations, palisades, causeways, and an emergency gate.

Architectural Features

Altogether 147 culture pits, representing for the most part dwelling foundations, have been excavated by the Expedition. Nineteen definite huts, well defined by traces of posts, and approximately 25 apparent huts, suggested by the grouping of sub-pits and their material, were found. In all cases, with the sole exception of the complicated, superimposed deposits in No. 33, the pits and posts were originally cut into the soft shale foundation of which Homolka is composed. In effect, negative impressions of the original structures were retained in the site, filled in course of time with humus, and then preserved to the present day. In the light gray filite shale, humus discoloration indicating the presence of former cultural activities was easily recognizable, and it required care and patience to remove the debris and reveal the features contained in the ground. Huts were found to run in rectangular shapes, approximately 4.25 m. to 6.50 m. in length, and about 3 m. to 5 m. in width. Three rows of posts, two walls, and the center line supporting the ridge pole are characteristic of the earlier huts. Sub-pits, three or four in number, are the usual occurrence. Functional features of these could

be distinguished in certain cases. Thus a fire pit, work-shop pit with stone anvil, cooking pit with clay bench, and refuse and ash pits were observed. Fireplaces built upon clay foundations, and in one case with a carefully constructed pebble bed, have been found in all huts. In several instances, posts in peculiar alignment highly suggestive of benches have been uncovered.

The simpler hut form seems, for the most part, to have had a ridge pole supported by heavy posts, which ran longitudinally down the center. Large posts at the corners suggest that the main framework was relatively massive, while along the walls, where indications remain, light poles appear to have been employed. The presence of the ridge pole automatically presupposes a pitched roof.

Quantities of burnt clay, usually tempered with chaff but occasionally with sand, were found in association with the hut foundations, floors, and culture pits. The larger pieces show clearly the impressions of light poles and saplings running in parallel lines, while the reverse sides have usually been flattened, apparently with the palm of the hand, and in many cases show finger impressions evidently left in the wet raw material when it was applied.

The impressions found in this plaster may throw an interesting side light upon the form of construction. The immediate suggestion is that of wattle and daub. Wattling, however, connotes a framework of horizontal poles intertwined with vertical posts, but in the Homolka impressions there is no indication of bowing of the saplings. The imprints run straight, at a uniform depth or at a slant. There is, however, no trace of a rough wicker-work treatment.

From the plaster then it would seem that the walls were formed of series of saplings or light poles arranged parallel to each other, either vertically or horizontally, in the form of a screen which was in some way attached to the main framework of the hut. That the post holes found along the walls between the corners are usually scattered and shallow as well as small suggests that for the most part the vertical poles were not deeply driven into the ground.

That so much of this daub material should have been burnt seems scarcely to have been accidental. In a moist climate dried clay would wash away rather easily. It does not seem illogical then to recognize the possibility that the people of Homolka, already in possession of a developed ceramic ware and using a tempered clay for daubing and chinking their huts, may have adopted the principle of partially firing their wall plaster after application to render it permanent and water-proof.

In the more highly developed huts different forms of construction appear to have been used. As has already been indicated, the later dwellings are situated at the base of the slope in the territory added by the building of the second palisade. Here new principles are involved. In the earlier group the floors seem to have been left uneven and slanting, or built up from below to an approximately level base. In these huts, however, the builders started their foundations from the downhill side and worked toward the hill, excavating a flat and level floor as they progressed. This method left a standing wall, cut from the living rock at the back of the hut, and a similar base for the side walls. These rose from a few centimeters in height at the front to join the rear wall which ranged from 1.50 m. to 2 m. From the very nature of these foundations it is obvious that in the majority of cases the entrances must have been on the downhill side.

Some interesting variations of this later type appeared. One hut had a low step running parallel to the ridge pole, the other wall being formed by the natural rock. Overlying the center of the floor and the step lay a mass of jumbled rocks. It seems probable that these were piled on the step in a dry masonry wall with an outside row of supporting posts paralleling the cut rock face. In this instance the orientation of the house was opposite to the majority. Suggestions of dry masonry were found in three other cases.

Another hut of this type presented further unusual features. In shape it was roughly square. The front and side walls were clearly marked by regular series of post holes. In

the interior, however, further posts suggested two possibilities of construction. These were arranged in the form of an inner square, theoretically of nine units, but with the two uphill corners missing and a large post in the center. Instead of being sheer the back wall of rock was cut in the form of a terrace, and three irregular posts were found thereon. This hut, then, may have had a roof constructed in four triangular sections which sloped up to a central peak. That section at the back of the house would have rested against the terrace. The inner poles would serve to support frames carrying the diagonal posts. On the other hand, the center post may have combined with the middle posts of the front and back of the inner square to carry a ridge beam, while the sides carried longitudinal roof supports at a lower elevation whose ends rested upon the terrace at the rear. In this way the simple pitched roof would again be employed.

There are, of course, other factors and deviations, but these are the most striking.

It was not possible to determine the precise position of the entrances in the field, but in certain individual cases this could be adduced from interior arrangements or from associations and interrelations between the positions of the huts. The definite huts, that is those well defined by the posts, ran in a fringe along the western, northern, and eastern edges of the hill. The apparent huts seemed to form a row inside and parallel somewhat above them. The crest had comparatively few huts. The concentration of dwellings around the edges seemed to depend to some degree upon the arrangement of palisades which were built some time after the foundation of the settlement.

Two palisades were present. They represented two different periods and were not simultaneously in use. The first was constructed about two thirds of the way up the hill when viewed from the south. It was a narrow and rather shallow ditch, approximately 30 cm. in width and not more than 20 cm. in depth, prepared in the shale, apparently enclosing the hill on all sides. Sufficient evidence was found to uphold

the belief that originally this palisade completely surrounded the settlement, even though the remains of it recovered in the course of excavation showed three broken sections. Modern economic activities on the northern and western slopes of Homolka are responsible for the obliteration of the rest of the palisades chain. The posts of the stockade were set close together in the prepared ditch and driven deeply into the rock. In some instances it was clearly visible that the posts were finely pointed to facilitate their penetration into the shale, a matter of 60 cm. below the floor of the ditch in extreme cases. There was no evidence of the existence of any embankment along the palisade. Two causeways, constructed of a double row of heavy posts, six in number, were attached to this palisade. Hinge and back supports, as well as blocking posts, were found in the entrances. Whether these causeways originally served as raised approaches, or as mere gates, could not be determined. In many respects they resembled the crude mediæval fortification structures common to Central Europe. In the northwest corner of Homolka a narrow gate with overlapping protection was found. This may have served as an emergency outlet or as an approach to water supply in the valley below. The palisade, having originally been set in the rock formation of the hill, was relatively simple to follow. The break in its chain in the southeastern section can be explained as being due to clearing of the structure done in aboriginal times after the second palisade was built. Interesting and highly important evidence was found which proved the uprooting of this palisade after the second one was built. In the northeastern section of the first palisade, a large portion of a storage jar and large animal bones were found "in situ" and unbroken in post holes. These objects were jammed into the holes after the piles had been removed. Owing to their dimensions, they were retained fairly high up with rather loose fill underneath. This discovery immediately led to the search for other fortification structures and the search was rewarded by the find of another palisade, this time under the hill proper.

Its construction, however, differed materially from that of the first one. A broad ditch, approximately 1 m. on the average, was first prepared, being 20 cm. to 40 cm. deep. At intervals of roughly 2.50 m. heavy supporting posts were set, in some cases driven into the floor of the ditch and then shored heavily with slabs of shale, limestone, and quartzite. The ditch, together with 19 of these shored remains of the heavy posts, was found in its original position, although the whole structure had suffered considerably from ploughing. There are several possible explanations of the aboriginal appearance of this structure. Lighter posts may have been set between the heavy shored ones, then packed in with earth, and possibly further strengthened with an embankment of which a faint trace in the form of a walk was still visible on the inside. As destruction set in, eventually these ligher posts would have been uprooted first leaving little or no traces within the ditch, inasmuch as the material used in their packing may have been of the same composition as the natural fill which sifted in after the posts were gone. Thus the excavator may well have been deprived of the possibility of finding traces of such posts by the very nature of the original structure. Another possible explanation is that the posts between the heavy supports were placed horizontally, but any such reconstruction is largely a matter of guess work. The second palisade had a causeway laid out similarly to the two associated with the first stockade. Agricultural activities had destroyed much of its remains but the traces of all original posts, again two rows of six each, were well preserved. Some of the posts were shored; others had no trace of stone packing; but it seemed clear that originally all the posts of the gate were shored similarly to those in the palisade proper. At the entrance of the gate no traces of such a complicated structure as that of the other two causeways could be distinguished. Whether this was true in the aboriginal time, or is due to the work of the farmer, cannot very well be answered, for this particular section of the site was badly affected by agricultural work. Two fields had been lowered about 60 cm.

at each end of the still preserved chain of the second palisade, and soundings in those revealed clear cut termination of the palisade and a total lack of traces of the Homolka settlement. At the eastern end of this wall a row of small posts and a sharp turn in the course of the structure were found, faintly suggesting the possible original existence of still another gate. Here, however, the destruction by the plough had been so thorough that nothing was gained through careful search in all directions. The original height of these palisades can at best be only surmised. To be effective against attacks the posts would have to have been approximately 2.50 m. above ground. The inner palisade, set on a fairly steep slope, could have had lower posts. They were not set tightly together. In many cases burnt wall plaster, similar in composition to that found in the huts and pits, was recovered from the first palisade. This suggests that the structure was built somewhat along the same line as the huts. The use of daub certainly would have strengthened the wall considerably. Furthermore, it seems doubtful whether such a large quantity of plaster as was gathered from the first palisade could have accumulated there after the posts had been removed, although it is true that potsherds, bone, and stone implements, in limited quantities, did find their way in. In connection with the second or later palisade no plaster was found in the structure itself, and other material, such as pottery and animal bones, was really neglibible. The question as to why the second palisade was built and the first then uprooted is answered by the layout of the site. Between the two walls there was a zone of ground on the south side of the hill, approximately 15 m. in width, which afforded splendid additional building ground when it was enclosed within the fortress by the erection of the second wall. It was in this zone that architecturally the most advanced huts and culturally the latest material were found. The palisades serve as marks of time advance in the history of Homolka. The first palisade, in its northwestern section, ran through and over a group of pits which structurally antedate its erection. The material recovered from those

pits serves as a time check in relation to that recovered in more advanced huts located within the palisade wall. Evidence of this nature might be used in support of the existence of three periods of Homolka's occupation, namely: before the building of a palisade, simple dwellings without (apparently) heavy posts; the first palisade, enclosing the high portion of the hill, and characterized by huts with subpits and three rows of posts; the second palisade with the new added zone of occupation and the most advanced types of huts. Such distinctions, however, would mean very little from the standpoint of actual culture history, because the material itself did not change with the architectonic growth. It is true that foreign traits do not appear until the later stage of Homolka's development, but the purely local, cultural expansion cannot be separated into distinct phases. In spite of what might appear to be stratigraphic evidence, for the entire settlement does not represent a very long period of occupation, and prior to the appearance of the new elements from the south and the north, there are no indications of contacts with the outside.

General Remarks

The site stands out as a unique archæological monument in Central Europe. The ceramic material is not marked by the richness of heterogeneous composition so commonly found in other "Nordic" sites. It must be said, however, that the "Nordic" material excavated up to date comes from small units of dwellings or graves. There have, up to this time, been sites of the size of Homolka completely excavated in Central Europe. The significance of the work done by the American institutions in this site lies in the completeness with which the excavations were done. After a preliminary sounding accomplished in 1929, systematic work began in July, 1930, and lasted with minor interruptions until late October. Approximately 60 per cent of the site was excavated during that season. In 1931 the rest of the hill, with the exception of certain test blocks left intentionally for future check-up, the fields under it to the south, and the high ridge further south were excavated or sounded as need may have

required. The hill proper may be considered to have been 95 per cent finished. Permanent station points have been left in the major parts of Homolka, which should facilitate and speed up further work or revision in the future. The excavated features have been carefully refilled and, in many instances, American pennies of 1930 dropped at the bottom of the pits. The 1931 season lasted from August 1st until November 5th.

The material recovered at Homolka was inspected by the State Archæological Institute of Czechoslovakia and the American share shipped to the Peabody Museum in Cambridge, Mass., where it is now in the final stages of preparation for the complete report. In handling the material in the laboratory special attention is being paid to detailed study of the pottery, as well as to the architectonic features of the site. While further labor will be required before the final paper may be presented, it seems permissible to present this preliminary report as a brief indication of the nature of the site and the task involved in handling the field results.

The site of Homolka yielded remarkable evidence of a large and well organized fortified settlement dating from a period almost four thousand years ago. The duration of its occupation cannot be determined, and any estimate would be merely a guess at best. The material recovered there helps to establish more definitely than heretofore the cultural position of the so-called "Nordic" phase of the Neolithic Period in Bohemia, and calls for a revision of the established but unsatisfactory connotation of "Nordic." Several new cultural elements have been found in the site; the structural features, such as the large number of well-preserved huts with functionally distinguishable subpits and a series of developmental stages, and the mode of fortifications make Homolka an outstanding site not only in Central Europe, but on the entire continent. When all the material and the total nature of the settlement have been completely digested, and comparative studies made, the work of the Expeditions will be rounded into a comprehensive monograph which, it is hoped, will be published next spring.

THE COMING OF MAN FROM ASIA IN THE LIGHT OF RECENT DISCOVERIES

By ALEŠ HRDLIČKA

(*Read April 22, 1932*)

THE chief deduction of American Anthropology, in the substance of which all students concur, is that this continent was peopled essentially from northeastern Asia. The deduction is based on the facts that man could not have originated in the New World and hence must have come to the same from the Old; that the American aborigines are throughout of one fundamental race, the nearest relatives of which exist to this day over wide parts of northern and eastern Asia; and that the only practicable route for man in such a cultural stage as he must have been in at the time of his first comings to America, was that between northeastern Asia and Alaska.[1]

[1] Hrdlička, A, "The Problem of Unity or Plurality and the Probable Place of Origin of the American Aborigines." Symposium, Sect. H, A. A. A. S , 1911, Parts History and Physical Anthropology. *Am. Anthropol.*, 1912, XIV, 5–12, also Trans. VIII Intern. Cong. Americanists, London, 1913, 57–62; "Restes dans l'Asie orientale de la race qui a peuplé l'Amerique," Congres Internat. d'Anthropologie et d'Archeologie prehistorique, C. R. de la XIV^me session, Geneve, II, 409–414; "Remains in Eastern Asia of the Race that Peopled America," Smiths. Misc. Coll., Wash., LX, No. 16, 1–5, 3 pl., also C. R. XIV Cong. Internat. Anthropol. Archeol. prehist., Geneve, 1913, 409–414, also *J. Hered.*, Wash., 1915, VI, 79–91, Translat. in Russian in Trudy Troickosavsko-Kiachtinskago Otd. Imp. Russ. Geog. Obšč., 1912, XV, 70–75; "The Derivation and Probable Place of Origin of the North American Indian," Proc. 18th Int. Congress of Americanists, Lond., 1914, I, 57–62; "The Peopling of America," *Journ. of Heredity*, VI, No. 2, 79–91, 7 figs.; "Transpacific Migrations," *Man*, XVII, 29–30; "The Genesis of the American Indians," Proc. XIXth Internat. Cong. of Americanists, Wash., 1915, 559–568, 9 pls., 1 fig., Proc. 2nd Pan. Amer. Sci. Cong. (1915–16), I, 128–137; "The Peopling of Asia," *Proc. Am. Philos. Soc.*, LX, 535–545; "The Origin and Antiquity of the American Indian," Smiths. Rep. for 1923, Wash., Publ. 2778, 481–494, 17 pl.; "The Peopling of the Earth," *Proc. Amer. Phil. Soc.*, Vol. 65, No. 3, 150–156; "The Race and Antiquity of the American Indian," *Scientific American*, July, 1926, pp. 7–9; "The People of the Main American Cultures," *Proc. Amer. Phil. Soc.*, LXV, No. 3; "Anthropological Work in Alaska," Field Season of 1926, Explorations and Fieldwork of the Smiths. Institution in 1926, 137–158; "The Origin and Antiquity of Man in America," *Bull. N. Y. Academy of Medicine*, IV, No. 7, 802–828; "The Origin and Antiquity of the American Indian" (Revised Edition). From Smiths. Rep. 1923, 481–494, Publ. 2778, Wash.; "Ancient and Modern In-

The principle of the problem being thus settled, there remained the important details of when and just how Man came to America, what he brought with him in the lines of language, culture and physique, how he proceeded in peopling the new continent after he reached it, and what was the genetic relation of the Eskimo and the Indian.

On all these large questions new lights have been shed by recent explorations in the Far Northwest under the auspices of the Smithsonian Institution. Initiated by the author, these explorations have now been carried on in Alaska for six years, and that mostly by two parties. They comprise systematic work both in Physical Anthropology and in Archeology and have reached now over the whole west coast, from Point Barrow to Kodiak Island, and over the principal islands of Bering Sea. They resulted in the location of a very large number of old sites of habitation, in the collection of very valuable and ample skeletal materials from the entire region, in anthropometric data on the fullblood remnants of the living populations, and in the unearthing of unsuspected rich old cultures about the Bering Strait, on St. Lawrence Island, on the lower east coast of the Bering Sea, and on Kodiak Island.

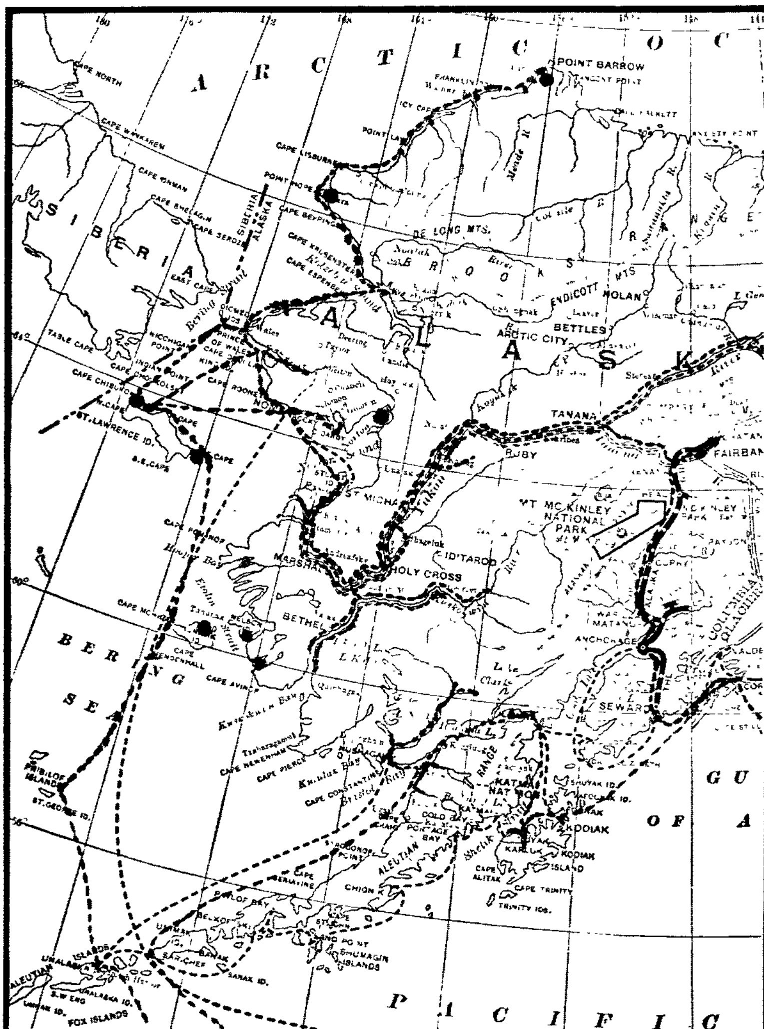
Thus what has been up to lately but a trail of theories through a jungle of possibilities has gradually been becoming a broad road paved with substantial facts and determinations. The work is not yet finished, but it will not be long before the main question at issue shall have been cleared. It may be well to state at once, however, that the evidence will not be of a simple nature, for wherever it has been possible to approach matters more closely they have invariably grown much in complexity. Furthermore it is also becoming plain that much of the direct desired evidence on human movements in the Far North can probably never be uncovered.

Before discussing the results, it may be helpful, with the accompanying map, to give a few details about the explora-

habitants of the Yukon," Explorations and Fieldwork of the Smiths. Inst. in 1929, Wash., 1930, 137–146; *Human Races. In Human Biology and Racial Welfare*, 8°, N. Y., 1930, 156–183: "Anthropological Survey in Alaska," 46th Ann. Rep. Bur. Am. Ethnol., Wash., D. C., 1930, 374 pp. and Index, 61 pl., 29 figs.

tions on which they are based. They are to-date briefly as follows:

1926. Survey of the middle and lower Yukon, the upper Bering Sea, and the coasts to Point Barrow, by A. Hrdlička.



Western and Central Alaska, showing roughly Writer's Travels (Dotted line) and Other Smithsonian Exploration (Circles).

1927. Continuation of the work along the west coast from Bristol Bay to the Yukon, with particular attention to the Nunivak Island, by Henry B. Collins, Jr., and T. Dale Stewart.

1928. Excavations on the Punuk and St. Lawrence Islands, by Collins.

1929. Anthropometric and archeological work along 1500 miles of the Yukon, by Hrdlička, aided by Dr. J. Maly. Excavations at St. Lawrence Island, Point Hope and other places, by Collins.

1930. Anthropometric and archeological work along the Kuskokwim, by Hrdlička. Excavations at St. Lawrence Island, by Collins.

1931. Anthropometry and archeology of the Nushagak River and its tributaries, of the proximate parts of the Alaskan Peninsula, and on Kodiak Island, by Hrdlička. Archeological work in the upper Bering Sea and the Arctic by J. A. Ford and Mr. Chambers.

The preliminary accounts of the work were published in the Smithsonian Exploration volumes for the respective years. More advanced reports are the speaker's "Anthropological Survey of Alaska" (26 Ann. Rep. Bur. Am. Ethn., 1930) and Collins' "Prehistoric Art of the Alaskan Eskimo" (Smithson. Misc. Coll., 1929). The main parts of the collections and data are still under elaboration and many years must elapse before the results can be fully given. But the essentials which these researches elucidate have assumed already a more or less substantial form, and they may briefly be summarized as follows:

The Bering Sea Islands, barring the Pribilofs, the western coasts of Alaska, the lower courses of the western Alaskan rivers, the Peninsula, and the Aleutian Kodiak as well as other southwestern Alaskan islands, are all rich in "dead" sites or villages. These may be found at the mouth of every larger fresh water creek and in other favorable locations. Many of the sites were relatively small, the settlement having consisted of but a few dwellings, but some were quite large, with a popula-

tion that reached well into the hundreds. The large majority have gone "dead" from the Russian times, generally through epidemics, and show no material age. But there are some in which the house refuse reaches many, in instances as much as 15 to 20 feet, and in which signs of white man's contact are either wholly absent or superficial, and these must go back for centuries.

Nothing whatever, however, was discovered so far that would indicate any greater antiquity. The total of the human remains that have become known to this day can undoubtedly be encompassed within what would correspond to the Christian Era and generally within the last half of it; and there has appeared thus far nothing that would give hope of earlier discoveries. In reality, the more the conditions in these regions are studied the fainter becomes the expectation of ever finding anything more ancient, unless this be through some rare accidental discovery. The fact is that over by far the most of the regions involved the ground on which human remains are now found is ground of recent formation, and that older places on which man may once have been settled have been washed away, or so covered with silt or loess and jungle that the location of the remains is now impossible.

The Bering Sea region as well as the coasts to the north of that are geologically alive, constantly cutting or building. The present coasts, the mouths of streams, the platforms suitable for man's habitation, were with rare exceptions not there 500 years ago, and one or two thousand years ago the whole map of these parts was different. Within the memory of living man whole sloughs (wide streams) have been silted up and wooded, whole bluffs, or villages with burial grounds, cut away, while new channels, bars, islands and dunes were built. Not even the rocky banks and coasts have been spared the attrition by the frost, wave and wind. It is now only too evident that all hope of finding the remains of the earlier migrants to America across Alaska must practically be abandoned. This is our main negative appreciation.

But there is also much on the other side of the scale.

Examination on the spot of the Bering Strait region shows plainly that, once man arrived into northeasternmost Asia the passing over to the easily visible and reachable American side was not merely possible but inevitable. The simultaneous appreciation is that not only was no land connection needed for such a passage but that, had the same existed, man would not have used it but would have followed the much easier route over the water.

The next major point that looms up conclusively is, that the coming of man over from Asia to America could never have been in the nature of a migration. Rude and barren as is the American territory nearest Asia, that on the Asiatic side is even ruder and colder and stormier, and as such it could never have accommodated any large population. There could have been therefore but a few people passing over at any time. These might have influenced the rest of their clan or group, but after that an interval would elapse before a new lot would reach the northeasternmost parts of Asia from which it in turn could come to America. There could therefore never have been any large or continued migration into America, but only relatively small and interrupted dribblings over.

Such parties as came, must have been parties of people well acquainted with and provided for coastal navigation, for their movements as well as their main livelihood in Asia depended on such navigation. They doubtless had small or individual as well as large or group skin boats, the latter probably with a skin sail, in which they could readily cross over. All this is shown by the inhabitants of the same region to-day, who in their skin boats cross over the Strait whenever they need to without much difficulty; only now they have to return, for the American side is already peopled.

The further problem was as to the movements of the newcomers after they reached the American side.

In viewing the map of western Alaska, it would seem most natural that people coming from Asia would soon reach the

delta of the Yukon, through this funnel pass into the interior, and from there to Canada, southeastern Alaska, and the rest of America. The actual examination of the Yukon, which is indeed a great artery, does not sustain this opinion. The river is 2700 miles long. It has a swift current, its waters are often quite rough, and both it and its tributaries ascend towards very rough icy mountains. And its valley is so plagued during the summer with mosquitoes, gnats and horseflies that all larger game leaves for the highlands. It was not impassable, and had doubtless been tried again and again, but that the peopling of America proceeded through its trough is neither probable nor supported by any thus far discovered facts.

It appears now much more likely that such moderate groups of fisherman and sea-hunters as have reached America, finding no one in the way, proceeded with but short stops towards the "sun," that is southward, skirting the inhospitable coasts until they reached the Peninsula. This, we now know, they found to be a regular sieve of passes with easy portages, and once over these the newcomers were in the Alaskan Gulf, or in Cook's Inlet, with the road to the Northwest Coast relatively easy and open. This was a shorter and less difficult route than that up the Yukon and brought the Asiatic man much sooner to regions that offered him inducements for a more permanent habitation. The oldest habitations of that nature are therefore, in all probability, in or along the Bering Sea and perhaps not even to be expected in other parts of Alaska, but rather in the favorable spots of the western coast of Southern British Columbia and in Oregon, Washington and California. The lower Columbia River basin and parts of California would seem especially propitious.

The next large questions on which our explorations have already shed much light, are those of what the Asiatic migrants brought with them to America in the way of language, physique and culture.

As to both language and physique, it may safely be assumed that if there were repeated comings of man, which view we have seen to be the most justified one, then there surely

came also differences in language and physique, for no two ethnic or even tribal groups are identical in these respects. That different physical types came in, moreover, we have already found sufficient evidence in the skeletal remains recovered from the Bering Sea and adjacent regions.

As to languages, much can now be discerned which formerly was in haze. The former general opinion was that all the varieties of languages and dialects found in the two Americas were of American development, and this argument had repeatedly been used in support of a great antiquity of man on this continent. This was, it is felt to-day, a superficial and unnatural assumption. The probability in view of the present lights is that a series, rather than one, of languages and dialects were brought over from Asia, to differentiate here and diverge further under the influences of time, isolation and other factors. Unless it is accepted that there was but a single coming to America and that by a single homogeneous group, the notion of but a single original language from Asia is impossible.

The evidence of the skeletal remains as well as that of the living, has a direct bearing on this problem. There are found in the two Americas perhaps as many as five or six types of the Indian. These types naturally must have developed somewhere and this may as well have been, it would seem, in America as elsewhere; but their characteristics, distribution and stability all speak for an old differentiation which, in some cases at least must have been, it seems, pre-American. The remains in Alaska, nearest the source, show no such homogeneity as would accord with the conception of a unique original type. From the point of physical anthropology we may in reality be confident that the comers from Asia, though all of one large human family, the yellow-brown, brought with them already considerable physical heterogeneity; and if this, then certainly also that of languages and culture. These are no speculations or theories but results of clearer insights into these matters arising from the later explorations.

These explorations shed, in fact, a direct and remarkable light on the question of what the Asiatic man brought with him culturally.

To this moment there is among American scholars the generalized notion that the American cultures were of essentially or even wholly American development. This would imply that the comers from Asia brought with them but a sort of undifferentiated simple culture on the basis of which the American developments took place; or that if they brought any specializations these were forgotton under the new environment. The answers to this from our excavations are, that the Far Northwest, in as far as we can reach, is culturally rich and varied; that the oldest of the cultures there discovered, namely, the fossil ivory culture of northern Bering Sea and the Asiatic Coast, is not only the richest in forms and most beautiful, but that it comes in full-fledged, and that its outstanding features may be followed deep into the new continent; and that other cultural evidences are coming up which connect directly on one hand with the neolithic attainments of Asia and on the other hand with the advanced elements in the cultures of the northwest coast and further southward, to the Southwest, to Mexico, and even to Central and South America. There are no introductions from the continent to the north. They appear initially in the north, with many ingrained adaptations to the needs of the subarctic fishers and hunters. And all the movements ever observed in those regions had been from the north southward, none in the opposite direction. The cultural evidence of the late explorations shows, therefore, that the men from Asia were coming over not as a raw material, but already as carriers of well advanced cultures of, in the substance, the American type, and from which further American developments, according to local needs and opportunities, could readily have taken place.

The early Old World ancestry of the American Indians connects, it is ever more strongly indicated by the accumulating evidence, with the Aurignacian and Magdalenian Man of Europe and northern Asia.

Finally, a word as to the new aspects of the problem of the genetic relation of the Eskimo to the Indian. The Eskimo appears to be a later offshoot from the same old stock that gave us the Indian. He came later and that already in two subtypes, one nearer to, the other farther from the Indian. The relation of the Indian and the Eskimo may best be represented by a hand with outstretched fingers. The diverging fingers proper are the different types of the Indian, the thumb, which should be doubled, representing the Eskimo. The thumb is farther apart, but originates from the same hand, which is the old Asiatic or sometimes called palæo-Asiatic yellowbrown strain, a strain that, according to the best evidence gave us the ancestry of all the aboriginal Americans.

The Smithsonian explorations in the Far Northwest will continue. There is ahead of us still an enormous amount of detailed labor. But the "principles" of the region are already fairly appearing and they promise to place, before long, much of our problems of American origins on firm scientific foundation.

SUMMARY

Since 1926 the Smithsonian Institution is carrying on renewed explorations and studies in Alaska relative to the origins of the American aborigines.

These explorations, partly somatological and partly archeological, are throwing new and important lights on the problems of the coming of man from Asia.

The main indications are that man came over very gradually and disconnectedly; that he brought with him already differences in type, language and culture; and that he did not proceed to people America across the mainland, but by skirting the western and eastern coasts of Alaska.

The Eskimo, the last comer, is a blood-relation of the Indian.

The material evidences of the early comings over may never be recovered in western Alaska which has suffered important geotechnic changes since man's arrival There is more hope along the Gulf and especially along the western coasts of the continent, from British Columbia to California.

FIRE AND HUMAN CIVILIZATION

By WALTER HOUGH

(*Read April 22, 1932*)

MAN is the only mammal that overcame the fear of fire. Taking up and domesticating fire is a human characteristic important beyond estimation. We can put forward the question whether failure to adopt fire would not have left the man beings a waning genus doomed to extinction. The only essential force available in nature joined with the wits of man became a combination of undreamed potentialities.

In the nebulous stages of the life of early man we can only infer the circumstance that led to the acquisition of fire. Nature supplied fire from the volcano, lightning, and perhaps other ways. The adoption of fire and its becoming a human need no doubt has a story of gaining fire, its care, its loss and recovery. In brief the earliest remains of man show that he had become habituated to fire. The problems of preservation appear to have been met. Losses of fire which occurred at intervals were met by long waiting for nature to respond with the opportunity or its borrowing from other groups, using primitive diplomacy in procuring a prized asset.

With the more or less fixed possession of fire and the assuming of its responsibilities, we may assume that there was a period of comparatively rapid differentiation of man from the feral state. It seems unquestionable that the fire association acted profoundly as a softening as well as a stimulating agent to the man being.

With the campfire or fireplace appear several of the primary elements that have entered into the history of civilization. These may be suggested as technological and social, the former being secondary in the early phases. It is conceived that social organization and primitive law were

principally in course of formation. The use of fire as suggested required special work and services, as fuel quest and watching. It is more than probable that there was at this time a delegation of certain duties which became very important in succeeding ages in connection with religion.

The knowledge of the behavior of fire was derived from observation on its action in the burning of wood, the flame, heat, smoke, soot, ashes, and odors, together with its effect on the hearth of stone or clay. In these common observations are seen the technological processes that are to be developed in the future with the control of fire. In this state of human society there is no necessity for the developing or use of technological process. Attention is called merely to the great range of data to be observed in the common open fire bearing on future civilization.

There is seen from remote times a slow but definite progress in civilization. Population increased with equal pace. With numbers there was a demand for more culture materials developing out of human needs. This is what we now recognize as the visible evidences of civilization. The period to which the world has moved is the neolithic, epochal in the history of civilization. There begin here applications of fire unknown in previous ages, that is, control of fire as a tool. There is no clue to the first shaping of clay, but, as suggested, the action of fire on clay must have been observed long before clay was made utilitarian by treatment in the fire. Pottery furnishes the imperishable evidence of the controlling or focusing of fire for a definite purpose.

With pottery there came clues as to the class and art of all succeeding periods. The potter's art indicates a growth of conservative tendencies of man, a more settled condition and an elaboration of household impedimenta besides the entrance of boiling in preparation of food. The new era of the Neolithic furnishes innumerable evidences of the arts and industries that would be elaborated in subsequent periods.

Tracing the potter's art we affirm that the control of fire in the baking of formed clay vessels in the open kiln was an-

cestral as to experiences to the art of smelting metals in the Bronze Age. The effect of wind on the increased heat of the fire, no doubt an observation from the primitive fire art, became known technically in the Bronze Age and was developed to a higher degree in the Iron Age.

The history of the technical use of fire is in the line of increased heat derived by simple bellows and continuing to the threshold of new age inventions.

The smelting process of the Bronze Age familiarized man with glassy slag, and out of this by-product of smelting we see the evolution of glass and glazed pottery, important adjuncts of civilization.

Fire as an associate of man at last is taken into the dwelling, thus reflecting changes of environment and profoundly modifying architecture. Diverging from the technical uses of fire we have apparently from the functions of the primitive fire keeper a great number of usages in creed and cult. Central point of undeveloped religions with crude fire altars, we have fire coming down to sacrifices in the great religions. Together with these are innumerable folk practices which trace out of ancient fire cults. The softening effects of these views of the intangible are observable in the growth of civilization.

The growth of the uses of fire is marked from the Neolithic and early historical periods. As light we have beacons, bonfires, torches, and various signalling. The chase of animals, perhaps aiding in the domestication of several species, the cutting of timber, and the clearing of land for agriculture declare the essential aid of fire in the growth of human well being, which is one of the aims of civilization.

Brought together in foci intimately connected with aggregations of population, the various uses of former periods came into new developments of invention. Light becomes more necessary and the developments along that line form an interesting series. Alloys of metals grow out of the knowledge of smelting copper and tin to form the ancient bronze. Out of this smelting comes brass, that most useful alloy of civilization.

As the technological aspect becomes more predominant the arts and industries fostered by fire take on new development that culminates at the flash point ushering the age of tremendous material progress.

The Iron Age brings forth steel, at first so far as we know an accident and extremely scarce before a more or less accurate method of its production was found. This condition prevailed until far in the new iron age the alloy was manufactured in quantity. With steel well nigh basal in the mechanisms of the age of invention we see as a miracle the great things of modern civilization ushered forth.

In the vast complex crossing at every angle we see unending creations that grow from the intelligent use of fire. Millions of products touched by fire surround us. They would strike less developed beings with awe; they prevent us from thinking of the machine and the mechanical servants that minister to our wants.

The savage kept his little glimmer of fire carefully, the modern puts fire to everything with no thought of conservation.

In the vast complex of modern civilization we can distinguish numerous lines that have contributed to the result. Some of these are not even remotely fire aided. They are phenomena of the human mind emerging on planes above material culture.

The importance of fire as an aid to civilization lies in its early fostering of the man being, its part in development of the basal arts which are the foundations of civilization and its part in philosophy, creed, and cult. Inventions of the modern age have tended to subordinate fire to a historical relation. It is prophesied that the utilization of other natural forces will render fire needless in future civilization.

In the history of fire invention one of the greatest names is that of Benjamin Franklin. He saw with a great vision that the essential feature that had slowly mounted with the ages was the increase and regulation of draught. Benjamin Franklin was the father of the modern technology of draught. What Dædalus did with the bellows Benjamin Franklin did in co pelling the fire to furnish its own draught.

PROBLEMS AND OBSERVATIONS CONCERNING THE TRANSMISSION OF BLACKHEAD INFECTION IN TURKEYS

By ERNEST EDWARD TYZZER

(*Read April 21, 1932*)

A PROTOZOAN infection which as it occurs in turkeys is widely known as blackhead, presents certain problems in parasitism of more than passing interest. While the causal organism of blackhead was discovered many years ago by Theobald Smith, and the changes in the diseased organs later on quite generally recognized, it is only in recent years that we have come to understand something of its transmission. The traditional belief in the fatal consequences of turkey poults wetting their feet has been found to be without foundation, the real source of trouble being in the practice of allowing turkeys to mingle with common poultry or to range over ground which previously was occupied by poultry. Whether infection in turkeys is derived from common poultry was for a long time a disputed question, but all that is required to demonstrate this is to add to the ration of young turkeys, a moderate amount of soil taken from a poultry run. In our hands this procedure has never failed to produce blackhead in young laboratory reared turkeys. While blackhead infection is beyond question very widespread in chickens, it is possible nevertheless that occasional flocks are free from it. Exceptionally a certain degree of success in rearing turkeys without careful isolation from other poultry has also been observed, but we have no data as to the presence or absence of infection in such instances.

On investigating the chicken as the source of the disease manifested in turkeys, it is found that the infection in chickens although varying in severity is usually mild and followed by

prompt recovery, but the organisms thereafter continue to multiply in the cæcal contents for indefinite periods and are passed daily in great numbers. Often the infection produces no visible evidence of disease and the "carrier" state is established at once. For a long time it was assumed that infection is transmitted in a direct manner and by the ingestion of food contaminated with the discharges of diseased birds. Experimental attempts to transmit infection in this way have either failed or furnished results so irregular that they could not be interpreted. It is now quite obvious that a healthy chicken carrier is a much more reliable and fertile source of infection than a sick turkey in which the cæca are often no longer functioning. Direct transmission may follow the experimental exposure of young turkeys to infected birds, in result of the contamination of food by the discharges of the latter.

While the possibility of the transmission of infection by the ingestion of freshly passed discharges containing the blackhead protozoön is demonstrable, it does not account, however, for the occurrence of the disease in young turkeys that have never been associated with chickens or older turkeys. The discovery by Drs. Graybill and Theobald Smith that blackhead may be produced by feeding large numbers of the embryonated eggs of *Heterakis gallinæ*, the cæcal round worm of poultry, has proved to be of considerable importance. Although the conclusion of these investigators that the cæcal worms served to break down the defences of the host, enabling the protozoön already present to invade the tissue, has not been supported by subsequent work, the fact established has led to the subsequent demonstration that the infection is actually introduced by the worm egg.

Thus while the blackhead protozoön as it occurs free in the cæcal discharges survives for only a brief period, in the egg of the cæcal worm it survives for long periods and passes unscathed through the successive freezing and thawing of our winters. Although the experimental evidence of the occurrence of the blackhead protozoön in the worm egg appears

to be conclusive, its presence here has not been demonstrated microscopically. It is found infecting the intestinal tract of a certain proportion of the growing worms, but the route by which it travels to the reproductive system has not yet been ascertained. One of the various working hypotheses now being considered is that the protozoön multiplying in the intestinal tract of the male worm is on occasion injected into the uterus of the female during copulation, since in the male both the alimentary tract and the reproductive system discharge through a common cloaca. Although it may appear to be a very simple problem to follow the development of the protozoön within the worm, many unexpected obstacles are encountered. Not all cæcal worms carry the infection, and a blackhead-free strain of this parasite is at present being propagated in the laboratory.

The wide dissemination of the worm eggs over the soil makes it clear how the infection is acquired by young birds reared entirely apart from older stock. The survival qualities of the blackhead organism as it occurs within the worm egg are quite remarkable. Thus *Heterakis* eggs that have been incubated for four weeks at 38° C. have produced infection. Since the blackhead protozoön finds the most favorable condition for its multiplication in the cæca of the chicken and since it is able to utilize a parasitic worm of this host for its transmission, we are led to believe that the chicken is the natural host of the blackhead parasite.

The infection is not only transmitted to the turkey with disastrous results but other avian hosts are affected as well. It is especially fatal to the ruffed grouse and regularly accounts for the most of those raised in captivity, but on account of the feeding habits of this species, it occurs rarely, if ever, in the wild state. Quail reared in captivity also frequently show this disease but appear to be somewhat more resistant than the grouse. The disease is especially serious to susceptible game birds that have the habit of feeding on ground ranged over by poultry. Thus numbers of fatal cases of blackhead are encountered in prairie chickens and this disease

has doubtless been concerned in the all but complete extermination of the heath hen on Martha's Vineyard Island. Several birds of the latter species dying near the keeper's residence showed the characteristic lesions of the disease and the blackhead protozoön was found in stained sections of the diseased tissues.

The possibility has been considered of the ring-necked pheasant serving as an intermediary in carrying blackhead infection from the poultry run to wild game birds. However, only negative results have been obtained from various tests carried out with this species. Carriers have not been found among pheasants nor have we been able to produce carriers artificially. Furthermore the eggs of large numbers of cæcal worms collected from pheasants fail to produce blackhead when fed to young turkeys.

The blackhead protozoön may be grown in culture with bacteria. Under cultural conditions, it thrives upon minute particles of starch derived from the splitting of starch grains by associated bacteria. A culture originally markedly pathogenic for chickens, on being propagated for a period of two years, is now found to be no longer pathogenic. The organisms of this old culture, on multiplying for a time in the chicken's cæca serve to protect the bird against subsequent inoculations of pathogenic strains. Under such conditions, superinfection is shown to occur and the presence of pathogenic organisms in the tested immune bird is demonstrable by passage to normal unprotected birds. The basis of the immunity produced is a problem for further research and furnishes unusual opportunity for the study of protective reactions in connection with a protozoön infection. The lack of generally applicable principles is perhaps one of the more outstanding characters of parasitism in general, and in place of the simple and what may appear to be the obvious, it is the unexpected that seems to be the rule.

FURTHER STUDIES OF AUTOSYNTHETIC CELLS WITH SPECIAL REFERENCE TO THE POSSIBLE RÔLE OF THE NITRO GROUP IN THE ENERGY PHENOMENA OF PROTOPLASM

By GEORGE CRILE, OTTO GLASSER, MARIA TELKES and AMY ROWLAND

(*Read April 21, 1932*)

IN THE first period following fertilization, the energy of the newly formed organism is used solely for growth and cell division. At a certain time thereafter differentiation of the cells and organs for the performance of specific functions begins to appear. As energy is utilized increasingly in proportion to the development of these specific functions in the muscles, glands, nerve tissue, etc., growth is by so much diminished, until finally a balance is reached when there is no further growth and all the energy of the organism is expended in function and repair. This applies to all normal tissue.

Under certain abnormal conditions, however, certain cells exhibit a capacity solely for growth but exhibit no function. Such cells have the essential characteristics of cancer. It would seem as if cancer cells had been bereft of that mechanism which is present within normal cells, by the exercise of which their specific function is performed; as if the only mechanism left is that which uses its metabolism for growth alone. To test this conception we endeavored first to discover the properties of the separate fractions of normal cells.

A further consideration of the individual cells of the organism and of the sex cells elicited the significant fact that the nucleus of a cell is principally protein while the cytoplasm is principally lipoid.[1] The head of the spermatozoön consists

[1] Mathews, A. P., *Physiological Chemistry*, 5th ed., New York, 1930, pp. 165–184.

principally of protein while the cytoplasm of the ovum which consists principally of lipoids is much larger than the nucleus which is principally protein. In all the organs and tissues excepting the brain and nervous system, proteins predominate over lipoids. The organization and the constituents of the brain and nervous system are ideally adapted for the conductance of stimuli but here proteins are present also and the phospholipins contain the essential constituents of the proteins, namely, a nitrogen fraction. As soon as the nitrogen fraction is lost, the phospholipins are converted into neutral, inert fat. All the active tissues then contain these nitrogenous and non-nitrogenous elements which reach their highest differentiation in the proteins and carbohydrates of which all living tissues are composed.

Since the brain is the most highly active and most highly differentiated tissue in the body, it occurred to us that if we should extract separately the lipoids and proteins from the brain and make a solution of the ash and should then mix these together, we could reproduce roughly the process by which lipoids, proteins and electrolytes are assembled in nature to produce living structures.

We therefore separated these fractions from brain tissue and then united them again and thus formed models of cells which exhibited such phenomena of living cells as assimilation, respiration, growth and cell division.[1] Upon these structures, which we called *autosynthetic cells*, anesthetics, narcotics, electrolytic solutions, the thyroid hormone and adrenalin produced effects similar to the effects of these agents upon the amœba, man and other animals. Of particular significance was the finding that for a period of eight months successive generations of these cells could be produced provided proteins, extracted from the brain of the same species of animal as that from which the original extracts were secured, were added from time to time. These proteins were apparently assimilated as food and apparently supplied the

[1] Crile, George, Telkes, Maria and Rowland, Amy F., "Autosynthetic Cells," *Protoplasma*, 1932, **15**, 337–360.

requirements for the production of respiration, growth and reproduction. Throughout the period during which these phenomena were manifested carbon dioxide and ammonia were excreted.

The autosynthetic cells apparently could not assimilate any other substance, that is, they could not utilize lipoids, or carbohydrates, or blood serum or any form of culture medium —beef broth, agar-agar, etc. Only proteins derived from the same species as that from which the lipoids were extracted could be utilized either in the formation of the autosynthetic cells or in the maintenance of their physiologic activity; and from this protein consumption there was elaborated not only metabolism and reproduction but also the production of ammonia which is an end-product of nitrogen metabolism.

Our findings raise the question as to whether or not the normal cells of animals actually utilize glucose or any carbohydrate as such as the final step in obtaining energy required for growth, function and reproduction, and whether it is not more probable that the carbohydrates like the proteins, are burned only in chemical bonds with nitrogen. This question is raised not alone by the facts observed in the activity of the autosynthetic cells but also by the fact that during muscular contraction no atmospheric oxygen is required,[1] as shown by muscle contraction on stimulation when atmospheric oxygen is excluded.

If carbohydrate metabolism were the final source of animal energy, one would not expect an end-product of nitrogen metabolism, namely, ammonia to be given off and yet Parnas and his co-workers have demonstrated the production of ammonia in muscular contraction;[2] Tashiro[3] has demonstrated the production of ammonia by nerve fibers during the passage of action currents; and we have found that the autosynthetic cell produces ammonia.

[1] Hartree, W. and Hill, A. V., "The Anærobic Processes Involved in Molecular Activity," *J. Physiol.*, 1923, **58**, 127.

[2] Parnas, J. K., Mozolowski, W. and Lewinski, W., "Der Zusammenhang des Blutammoniaks mit der Muskelarbeit," *Biochem. Zeitschr.*, 1927, **188**, 15–23.

[3] Tashiro, S., "Studies in Alkaligenesis in Tissues. I. Ammonia Production in the Nerve Fiber during Excitation," *Am. J. Physiol.*, 1922, **60**, 519–543.

If we are correct in our assumption that the carbohydrates like the proteins are burned in chemical bonds with nitrogen, then the production of carbon dioxide should bear a certain relation to the production of ammonia. Warburg[1] has measured the relation of the ammonia taken up by algæ to the amount of carbon dioxide given off by them and has found the proportion of absorbed nitrogen to the amount of excreted carbon dioxide to be as one to two. If the algæ are placed in the sunlight this relation is changed completely, the energy of the sun's radiation being used for the synthesis of CO_2 but the nitrate reduction to ammonia still goes on.

The formula for the first of these reactions is supposed to be as follows:

$$HNO_3 + H_2O + 2C = NH_3 + 2CO_2.$$

One part of this reaction—the formation of NH_3—is heat-consuming and requires 68,000 calories. The other part—the oxidation of carbon—is heat-generating and produces 230,000 calories. Therefore, the part of the latter which is utilized in the production of ammonia, is 30 per cent. The oxygen used in this reaction is not derived from the air but from the nitrate in the soil and the nitrate in the soil obtained much of its nitro- or energy-fraction from the NO_2 formed by atmospheric electricity.

If our assumption that reactions similar to these take place in the proteins and carbohydrates of our autosynthetic cells is correct, then there should be established a certain ratio between the carbon dioxide and ammonia output of the cells; and heat should be absorbed during the active synthesis of the cells.

These points were put to experimental test with the following results:

The respiratory quotient of the autosynthetic cells was found to range between 0.8 and 0.9; and it is interesting to note that this is the range of the respiratory quotient for bacteria (*B. coli*).

[1] Warburg, O. and Negelein, E., "Über die Reduktion der Salpetersäure in grünen Zellen," *Biochem. Zeitschr.*, 1920, **110**, 66–115.

In an average of sixteen tests, the relation between the CO_2 output and the NH_3 production was as 33 to 1 which, within the limits of experimental error, agrees with the ratio found for bacteria (*B. coli*).

During the period of formation of the autosynthetic cells, that is, during the first 10 minutes after the mixture of the protein and lipoid solutions, heat was absorbed as demonstrated by a loss of temperature in the suspending solution—an absorption of 16 calories per 100 cc. After the period of formation of the cells there was a heat production of 46 calories for one hour.

Repeated control tests of the temperature of the protein solution alone were made. When the autosynthetic cells were destroyed there was a transient heat production corresponding to that found by Lepeschkin [1] when yeast and erythrocytes were killed.

These facts, the protein content of the active part of the cell—the nucleus, the protein content of the active sex cells, the presence of nitrogen in the active lipoids, the assimilation of proteins and only of proteins by the autosynthetic cells, the absorption of heat, and the products of nitrogen metabolism, suggest that nitrogen-bearing compounds rather than the carbohydrates are the final source of animal energy. In other words, these facts raise the question as to whether the carbon compounds and the nitrogen compounds, like the lipoid and the protein fractions of our autosynthetic cells, are not built up in the cell by linkage into a higher nitrocarbon compound and disrupted and oxidized anærobically, thereby generating energy for growth and function.

If such a conception be correct then this disruption and anærobic oxidation of the linked nitrocarbon compounds in the production of our autosynthetic cells should produce radiant energy. A research along this line was undertaken by the methods employed to register different types of rays, such as the spectrometer or bolometer. While these methods

[1] Lepeschkin, W. W., "The Thermic Effect of Death and Hemolysis," *Am. J. Physiol.*, 1930, **95**, 473–480.

are of reasonably high efficiency they were not sufficiently sensitive to detect the radiant energy emitted by the autosynthetic cells. For this reason we constructed an apparatus which consists of a combination of a photo-electric cell with a Geiger-Mueller tube counter. The selective maximum of this apparatus lies in the ultraviolet region at 2200 ångström and it lends itself well, therefore, to experiments with mitogenetic radiation, the maximum effect of which has been found to occur around this wavelength.

Discharges within the photo-electric cell caused by electrons emitted from the photo-electric material by radiation from a living substance cause "kicks" of the string of an electrometer which is connected with the system. These "kicks" are recorded on a tape recorder through the medium of a multistage amplifier. In addition to these "kicks" caused by radiating material there are constantly present deflections due to the tested material, to the natural radio-activity of the earth, and to the cosmic radiations.

When a solution of the protein fraction of the autosynthetic cells was placed in the field the number of deflections of the electrometer was not increased but when a solution of the lipoid fraction was added to the protein solution, the number of deflections increased by about 10 per cent. This increase continued for about 10 to 15 minutes after which it decreased rapidly.

In accordance with the findings of Gurwitsch [1] we have observed mitogenetic radiation in growing onion roots and in growing yeast. It would appear that the radiant energy produced as the result of chemical affinities between the elements of which our autosynthetic cells are formed is on the same order as that produced as a result of the synthesis of carbon and nitrogenous compounds in the living by the sun's radiance.

These findings suggest the presence in protoplasm of generators of radiation. That this is the case is certainly indicated by the detection of the emission of radiant energy during the synthesis of autosynthetic cells.

[1] Gurwitsch, A., *Die Mitogenetische Strahlung*, Berlin, 1932.

A study of the essential characteristics of explosives shows that the incorporation of nitrogen into a stable carbon compound confers upon that compound a striking property of instability thereby converting it into a sensitive labile explosive. All nitro-explosives have one important property in common. They are so unstable chemically that they are continuously decomposed very slowly.

In the living cell the nitrocarbons have been built up from the stable carbon compounds, that is, the carbohydrates have become combined with an unstable nitrogen compound. It is obvious that the carbohydrate fraction alone would be too stable to form an animal and that the nitrogen fraction alone would be too unstable. In all nature there is no known carbon plant or animal, there is no known nitrogen plant or animal. All animals, like the explosives commonly used, are nitrocarbon compounds. In nature, the element nitrogen and the element carbon are joined in a biologic union. Alone and not combined with nitrogen, neither the carbohydrates nor the fats can burn in the animal organism.

If this conception is correct then it becomes necessary to consider whether or not the manifestations of the energy of protoplasm bear any relation to the presence of the linked nitrocarbon compounds in the cells. Let us first consider the source of the nitro group in protoplasm and in explosives.

In 1908, Arrhenius estimated that the amount of fixed nitrogen that is annually washed down upon the earth in rain is 400 million tons. He believed that a large part of this vast amount is fixed by lightning, principally in the form of NO_2. Nitrogen-fixing bacteria in the soil produce even a greater amount of fixed nitrogen. As the lightning forms the powerful nitro-group with its potential energy so the sun's radiance in conjunction with metal catalysts synthesizes CO_2 and water into carbohydrates which hold other stores of potential energy. From this fixed or nitro group created by atmospheric electricity and these carbohydrates synthesized by the sun's radiance are developed the nitrocarbons which constitute the energy units of protoplasm.

Would this theory that energy is due to the disruption of nitrocarbon compounds in the cell meet the instantaneous energy requirements of the animal organism? Among the nitro-explosives, nitrogen chloride is so exquisitely sensitive that it may be exploded by air waves generated by the closing of a distant door, by the slightest contact with the delicate fringe of an oiled feather or even by a beam of light. Is it surprising then that light can initiate the transformation of energy in animals when it falls upon the linked nitrocarbons known to be in the retina in large amounts? Just as nitrogen chloride may be exploded by the closing of a distant door, so the nitrocarbons of the internal ear may be disrupted by vibrations from the string of a violin. The specific difference between the nitrogen chloride outside the living and the nitrocarbons in the eye and in the ear is that while the nitrogen chloride outside the living may be exploded by any impact, the nitrocarbons in the eye and in the ear have become attuned for detonation by specific vibrations.

Both the nitro-explosives and protoplasm are highly sensitive to heat and electric stimulation. In fact in protoplasm electric stimulation and physiologic action currents are probably identical.

These are but a few of the physiologic facts that may be explained by the theory that animal energy is caused by the disruption and anærobic oxidation of the exquisitely sensitive nitro-molecules.

These nitro-compounds in the cells could never be glimpsed by the biochemist for they break down at death. The sensitivity of these nitro-compounds is paralleled only by the highest order of sensitiveness of the nitro-explosives.

In our study of the autosynthetic cell, as we have stated, we have had the unique opportunity of observing separately the characteristics of the protein or predominating nitrogen fraction and the lipoid or predominating carbon fraction. We know that alone neither the protein nor the carbon fraction can grow or multiply. We know that when united they behave, with respect to metabolism and growth, like the ovum

and sperm when united. We know that the maintenance of life, growth and reproduction depends on the consumption of protein. We infer, therefore, that the real intracellular "food" of animals is proteins which are built up from nitrogen and carbon compounds and which are probably synthesized or linked up in the cells into higher compounds.

We have shown that the emission of radiant energy emanates from protoplasm and that therefore the essential constituent is a dynamic unit. We believe that in this manner —by the emission of radiant energy—the energy imparted to the carbohydrates by the sun's energy and to the nitro group by atmospheric electricity is released. The energy thus mobilized by the nitrocarbons in the cell would seem to imply the presence of an adequate mechanism not only for charging up protoplasm, but also for enabling protoplasm to maintain growth, electric potential, electric capacity and heat. This theory of the disruption of nitro-molecules as a source of energy would account for the coincident production of ammonia and carbon dioxide in biologic activities. It would offer an interpretation of many of the phenomena of normal and of pathologic physiology, such, for example, as the overwhelming shock and exhaustion caused by injury and emotion; the exquisite sensitivity of the organs of special sense and of common sensation; the versatility and the speed of mental and muscular action; and we can glimpse the possibility that further studies of the functions of the carbon and nitrogen fractions in living cells may lead to an interpretation of the phenomena of cancer.

Summary

In the course of an investigation into the nature of protoplasm our attention was directed to the nature and action of nitro-explosives, a consideration of which suggested certain analogies.

Both nitro-explosives and protoplasm draw upon identical sources for their carbon fractions and their nitrogen fractions.

Both protoplasm and nitro-explosives owe their sensitivity to the nitrogen fraction; the greater part of the energy of each is obtained from the carbon fraction.

In both protoplasm and nitro-explosives there is an anaerobic oxidation; both break down into carbon dioxide, water and nitrogen end-products, emitting radiant energy in the process.

The chemical union of the nitro-group with a carbon compound confers upon that compound the striking property of instability, thereby converting it into a sensitive, labile explosive, such for example as nitroglycerin.

So in protoplasm by the incorporation of the nitro-group into the carbon fraction of the cell an unstable compound is produced which is so exquisitely sensitive that it reacts to heat, to light, to touch and to radiant energy producing in its responses the varied phenomena of life; that is, in accordance with this conception the activities of animals and of man, like the reactions of the autosynthetic cell, are the result of adjustments of the factors that govern the formation and activity of the nitrocarbons within the cells.

INDEX

N

O

P

11.2/48

"A book that is shut is but a block"

CENTRAL ARCHAEOLOGICAL LIBRARY
GOVT. OF INDIA
Department of Archaeology
NEW DELHI.

Please help us to keep the book clean and moving.

S. B., 148. N. DELHI.